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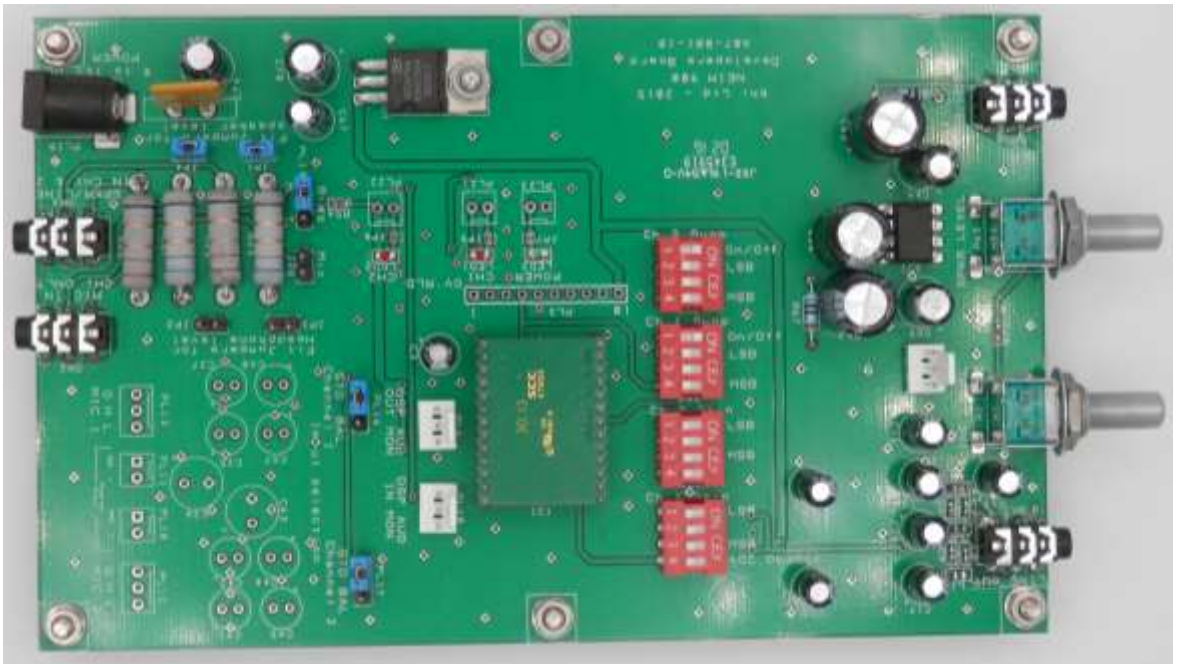


(Picture of a basic assembled unit)

Handbook for

NEDSP900 Development

Board

Document: HB07-003-10 Issue: B

Contents

1.0 Introduction

The **NEDSP900** is a dual channel audio DSP Noise Suppression pcb module for improving the speech quality in Voice communication systems used in noisy environments. It is capable of handling a wide range of audio inputs and providing up to 40dB of noise suppression. The module operates on a single supply rain with on-board voltage regulation and clock oscillator. It has low power consumption which makes it suitable for portable applications.

The module has a 26 pin Dual-in-line format with 2mm pin spacing allowing it to 'plug-in' to a standard 2mm pitch socket strip.

The NEDSP900 development board was to aid the design-in of the NEDSP900 module. The board allows various signals to be input to the module and then provides both a Line Out and a Headphone/Small speaker output to evaluate the processed signal.

Parts of the board have not been populated, but Circuits, Bills of Material (BOM) and information as to what components fit in these areas are given for the user to add to whatever level they require. This information can be found throughout this document, but specifically in Section 7.0 and the various Appendices.

The board has been created such that it can be mounted on standard M3 type pillars for ease of use. However the format also allows a standard extruded case to be purchased and modified to may this test board into a robust unit for field testing of the boards' properties.

1.1 Recommendation

We would like to suggest that you just take a few minutes to read through this document first prior to using the eval board. Some comments have been highlighted in **bold**, which you should consider before you connect this device up to your system.

1.2 Board Mechanics

The PCB is approximately 99.5 mm x 159.5 mm and is supplied with M3 x 10mm standoffs as supports (in 6 positions, see diagram overleaf). These allow components on the underside of the board to clear the bench. If the PCB is to be fitted into an enclosure, these standoffs may be used for this purpose or exchanged for shorter ones.

An extruded case can be used to house this board. This provides plenty of room for the board plus protection for initial system integration when carrying out larger projects. Information regarding this case and an alternative, if other supplementary circuitry is to be built in, is given in Appendix C. Drilling patterns for both the front and back covers can also be found in Appendix C.

1.3 General Specifications

Operating voltage:	8 to 16v d.c.

Note: While Current and Reverse Polarity protection has been built into the Power circuitry on this PCB, please check that the power lead is connected with the correct polarisation before applying power.

Audio Input Acceptance:	Input – Stereo (Audio 1 – Plug Tip/ Audio 2 – Plug Ring) 8 Ohms at 2Watts RMS 32 Ohms at 32mW 10K Ohm at 600mV p-p Balanced Audio Input amplifiers with Phantom Power facility have been provisioned, but not populated on the PCB (See Appendix B)
Audio Outputs:	Headphones/small speakers – 0.5 + 0.5 Watts into 8 Ohms Line Out - Both channels 600 Ohms at up to 0dBV
Connections:	Audio Input Mono Microphone Input Line Output Headphone/ Low power Speaker Output Power 2.1mm Coaxial Power Jack Various other connections using 0.1” connectors, mainly Molex KK, have been provisioned for monitoring and control purposes
Switches	4 off 4 Pole DIL Switches have been provided for the purpose of Gain and Noise Reduction control
Indicators:	Power ON Audio 1 Overload Audio 2 Overload

Important: Take appropriate Electro-Static precautions before handling the PCB and while making any additions or changes to the PCB components.

2.0 The Inputs

There are two main input sockets SK6 and SK7 that allow various levels of signal to be accommodated. Also, there are two balanced audio input amplifiers with Phantom Power capability. These amplifier circuits are included on the PCB, but not populated. The circuitry plus some explanation and the parts list are provided in Appendix B.

2.1 SK6 Speaker/ Line signals

This socket allows for stereo speakers/headphone signals to be input, matched and attenuated.

The input connection Tip is connected to Channel 1 of the NEDSP900 module, while the first Ring is connected to Channel 2 of the module. Each channel has attenuation/matching facilities that can be selected using Jumpers JP 1 through to JP4 as given in the table below:

	Low Impedance Speaker Level (8 Ohms/3 Watts)	Low Impedance Headphone Level (33 Ohms/30mW)	High Impedance Line level (10k Ohm/ 0.707 v p-p)
Input 1- Ring	JP1 (Not JP3)	JP3 (Not JP1)	None
Input 2 - Tip	JP4 (Not JP2)	JP2 (Not JP4)	None

Below is a picture to assist in the location of the above jumpers.

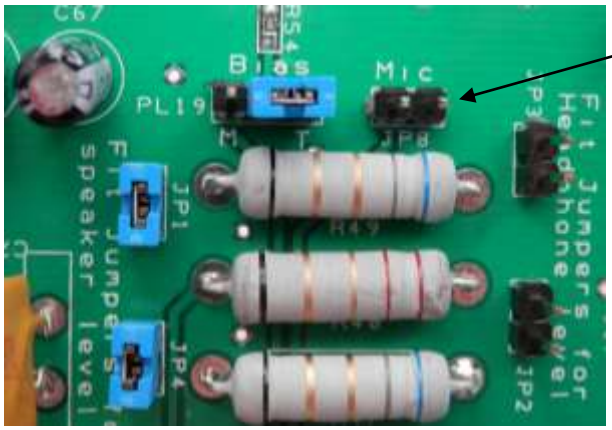
Above: Jumpers set for Speaker Level Inputs

Above: Jumpers set for Headphone Level inputs

Note: For Line levels, the Jumpers are removed altogether.

2.2 SK7 Microphone Input signals

A standard 3.5mm stereo jack socket is provided such that a Condenser Electret or other microphone may be connected to channel 1 only as this has higher gain settings and an AGC function that can be used if required.



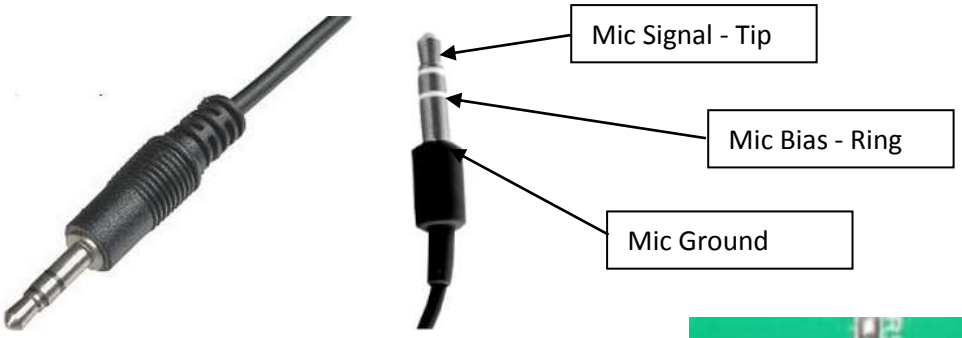
When using SK7, ensure that JP8 (Mic) is removed (this ensures no speaker signal is fed to Channel 1). Speaker level signals will only be taken from the Ring connection of SK6.

2.2.2 Electret Microphone Bias

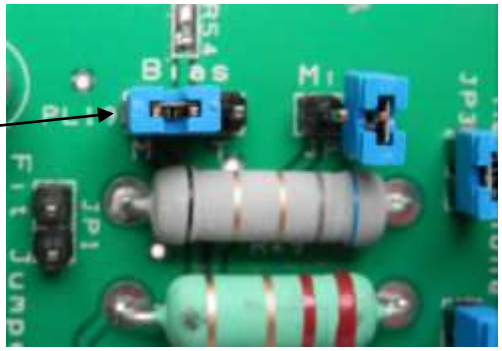
Most Electret microphones require some form of electrical bias. In some this is provide by an

internal source, such as batteries. To make sure that you are using the correct connections always check with the manufacturers' data sheet. The Bias is provided jumper PL19 this applies a fixed Bias to either the Ring or Tip of the jack plug. Of course if the microphone requires no bias or has an internal biasing system, then the Jumper across PL19 can be removed.

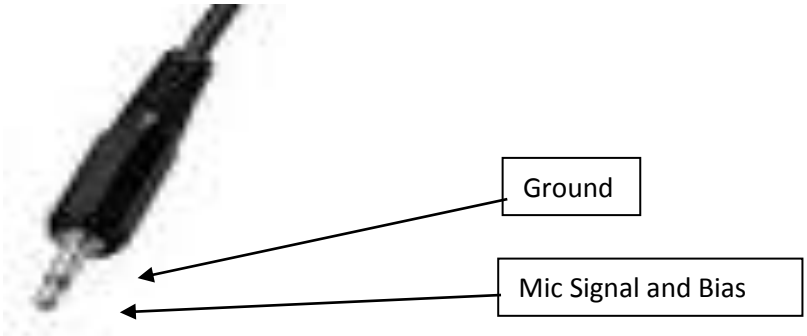
If the microphone is supplied with a Stereo 3.5mm jack plug on it, then it's likely that it requires Bias on the middle ring of the plug. This is standard for Microphone or Headset being used with a PC.



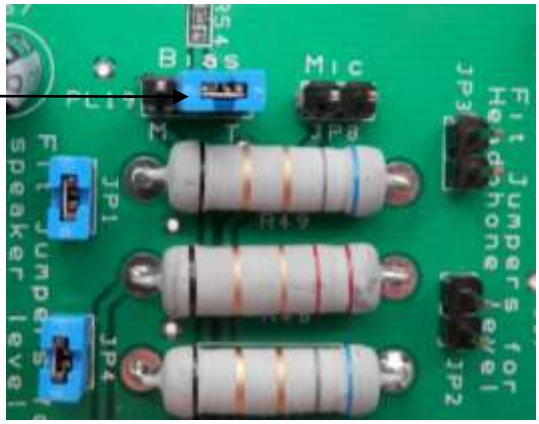
For a standard 3 wire PC type microphone place Jumper in position M (across pins 1 and 2).



If the microphone is supplied with a Mono Jack Plug, then the Bias is likely to be required on the Tip of the Jack.



For a two wire type electret insert place the jumper in position T (across pins 2 and 3).



If the microphone does not require any bias current, then the jumper PL19 should be removed altogether

2.3 Balanced input Pre-amplifiers

These can be configured with appropriate gains as required. As mentioned earlier the board is provided with tracks for these, but they have not been populated. Refer to Appendix B for further information on the components required for this feature.

2.4 Signal Input selection

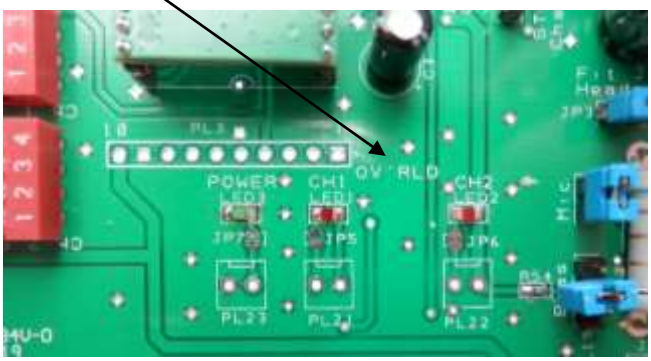
There are a variety of ways in which the PCB may be configured for input signals. However, the section on Gain Settings (section 3) should be read first in order to understand what signals should be routed to which section of the NEDSP900 module.

Below are some typical signal configurations that may be used.

Channel 1	Channel 2	Comments
Speaker/Headphone/Line	Speaker/Headphone/Line	Dual/Stereo Audio input from Radio or recording
Mono Microphone	Speaker/Headphone/Line	Communication System for Noisy environments
Balance Audio Signal	Speaker/Headphone/Line	Communication System for Noisy environments
Balance Audio Signal	Balance Audio Signal	Dual/ Stereo balance microphones or signals

2.5 Overload Indicators

Each channel has an Overload indicator (Marked OV'RLD on the PCB) these are located next to the Power Indicator.



The overload LED's indicate if the signals being fed into the NEDSP900 are too high for the device input. These indicators are set to trigger at signal levels of 1.4v P-P. The device is able to handle over 2 Volts P-P signal, but above 1.8 Volts the signal becomes distorted.
Where the single microphone (SK7) or the balanced input pre-amplifiers are being used, these indicators while monitoring, will not be effective as the signal will be much lower and you will be relying on the NEDSP900 internal gain system to increase the levels.

Setting the input level from SK6 Line through to Speaker Level

When inputting signals to SK6, it's recommended that you have the NEDSP900 Gains set to 0dB. You should have Jumpers J1 through to J4 set for the expected signal level and impedance. You can then adjust the input signal level as appropriate for a good audio output. If the Overload indicators start to flash, then reducing your input signal or change the jumper settings to a

higher input setting. If on the other hand you find that you have an insufficient audio level try increasing the source level or change J1 through to J4 settings for the next lower input level. When using a Line input make sure that the Jumpers are removed all together.

3.0 NEDSP900 Gain Settings

The NEDSP900 Gain is set using SW2 for Channel 1 and SW3 for Channel 2.
Channel 1 has a gain setting capability of up to 30dB, while Channel 2 has gain settings up to 18dB only. The reason for this, is that Channel 1 also has the AGC algorithm making use of the full 30 dB gain range which makes it useful for Microphone operation, especially electret modules without any pre-amplification. The following is the Gain Settings for this channel:

Gain (dB)	SW4 Gain Bit 2 (MSB)	SW4 Gain Bit 1	SW4 Gain Bit 0 (LSB)
0	OFF	OFF	OFF
12	OFF	OFF	ON
15	OFF	ON	OFF
18	OFF	ON	ON
21	ON	OFF	OFF
24	ON	OFF	ON
27	ON	ON	OFF
30	ON	ON	ON

Channel 2 has no AGC action and is designated as a Speaker or high level audio channel, therefore high gain settings are not required.

Gain (dB)	SW1 Gain Bit 1	SW1 Gain Bit 0 (LSB)
0	OFF	OFF
12	OFF	ON
15	ON	OFF
18	ON	ON

Note: SW1 – Bit 2 (MSB) is the Special Facility control and therefore has no association with the Channel 2 Gain setting

As a general idea of what to expect from the gain setting on either channel, the following are some typical input signals/results obtained while trying maintain an output of 600mV P-P at the different module gain settings. This was a single tone (1 kHz) test the DSP noise reduction was switched OFF.

You can see that the actual gain of the DSP module isn't actually what was set and therefore a certain amount of experimentation may be required to achieve the required settings for your application.

Channel 1 Input (mV P-P)	Gain 1 (Spec. dB)	Gain 1 (Meas. dB)	Channel 2 Input (mV P-P)	Gain 2 (Spec. dB)	Gain 2 (Meas. dB)
2000	**0**	0	1940	**0**	0
472	**12**	12.5	476	**12**	12.2
348	**15**	15.2	324	**15**	15.5
260	**18**	17.7	248	**18**	17.8
196	**21**	20.2			
140	**25**	23.2			
112	**27**	25.0			
88	**30**	27.1			

3.1 Setting the Gain for SK7 (Microphone input)

AGC Facility

Selecting the AGC function overrides the Gain setting switches and uses the internal firmware to select an appropriate gain between 9dB and 31dB, dependent on the microphone signal level. The AGC operates on voice signal only and therefore only responds to changes in voice level and not the general audio signal.

Manual Gain setting

A nominal gain setting for an Electret microphone would be about 28dB. This is set by selecting the gain using switches SW4 – see general section on Gain Settings

4.0 Using the DSP Noise Reduction

The Noise Reduction is individually selectable for each channel. Channel 1 is controlled by SW2 and Channel 2 by SW3.

The Noise Reduction settings are given in the table below with the settings referring to either SW2 or SW3.

Strength Setting	Noise Reduction (dB)	Switch 1 (On/Off)	Switch 2 (LSB)	Switch 3	Switch 4 (MSB)
Off/Bypass	Off/Bypass	OFF	X	X	X
1	8	ON	OFF	OFF	OFF
2	12	ON	ON	OFF	OFF
3	16	ON	OFF	ON	OFF
4	20	ON	ON	ON	OFF
5	25	ON	OFF	OFF	ON
6	30	ON	ON	OFF	ON
7	35	ON	OFF	ON	ON
8	40	ON	ON	ON	ON

When experimenting with the Noise Reduction levels, start with the lowest level and then increase the 'Strength' until you find a satisfactory level which is providing the necessary Noise Reduction without making the audio distorted or 'watery' where the audio artefacts sound like dripping water. This has a lot to do with the type of noise you are trying to combat as much the level of Noise Reduction.

Once you have found a suitable Noise Reduction level, note the value for future reference.

You can get a feel for how much clearer the Noise Reduction is making the signal by switching the DSP OFF and then back ON again.

Note: the DSP algorithm may take a short while to take full effect, approximately 500 mS, dependent on the noise content of the signal.

While playing with the Noise Reduction you may find that you have to increase the appropriate Output Level control as the effect of the Noise Reduction is to reduce the mean audio level so that everything sounds quieter. This is mainly because the noisy parts of the signal are being removed to improve the overall speech quality of the signal.

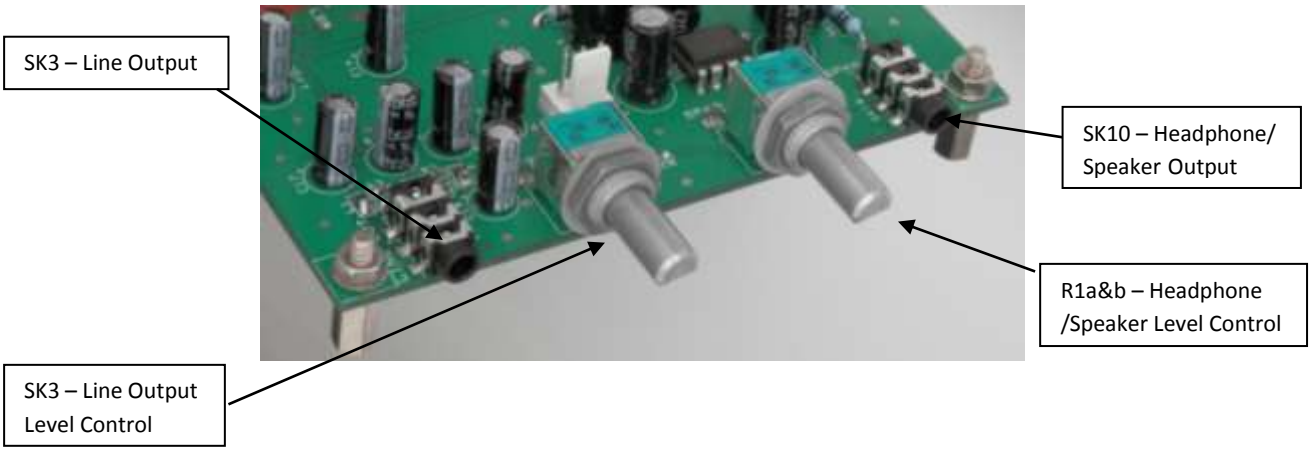
5.0 Outputs

There are two outputs available. One is provided to allow recording of results or for onward audio processing. The other is capable of driving a small speaker system or headphones. Each output is independently adjustable via the two edge mounted controls.

Users should be aware that as these are wired for Stereo Output. Monaural jack plugs should not be used as this could cause damage to the circuitry. If a mono output is required it is recommended that stereo jack plug is used with just the required channel wired. If in doubt, consult bhi Ltd.

5.1 Line Drive

This is capable of driving up to 1 Volt P-P into a 600 Ohm (resistive) load and can drive as high as 2Volts p-p into higher impedances. The gain of this output stage is fixed and the signal level is set by potentiometer R1 a & b located adjacent to SK3 which is the output socket.



5.2 Headphone/ Speaker output

This is provided using a TDA2822 low power amplifier. This is ideal for headset listening and small speakers only. It can drive into loads as low as 4 Ohms. The Audio level is set by RV65 a & b, located adjacent to SK10 which is the output socket.

6.0 Other facilities on the Board

To allow for monitoring of both input and output audio signals as well as allowing for external control of the NEDSP900 module from signals 'off the PCB' provision has been made for additional connectors, some of them already fitted and their use is easily identifiable from the Circuit Diagrams (see Appendix A).

6.1 Audio Monitor Points

A set of audio Monitor points has been provided for the user to 'hook' into the audio signals before and after the DSP module allowing for monitoring, signal injection and signal extraction from the Module.
These connections all use Molex KK connector series (see Connector Specifications – section 7.0). Their Pin outs are as follows:

Pin 1 = Channel 1, Pin 2 = Ground, Pin 3 = Channel 2

PL18 is the NEDSP900 Input Audio Monitor. Do not load these pins with impedances of less than 100kOhm

PL6 is the NEDSP900 Output Audio Monitor. Do not load these pins with impedances of less than 100kOhm

PL7 is the NEDSP900 Buffered Audio Monitor. Do not load these pins with impedances of less than 10kOhm

6.2 Noise Reduction Control

This is allows the user access to the Noise Reduction control lines of the NEDSP900 module. PL3 has not been fitted. This is a standard 0.1" (2.54mm) Pitch connector and suggestions for this have been made in section.

The Pin connection and designation is given here:

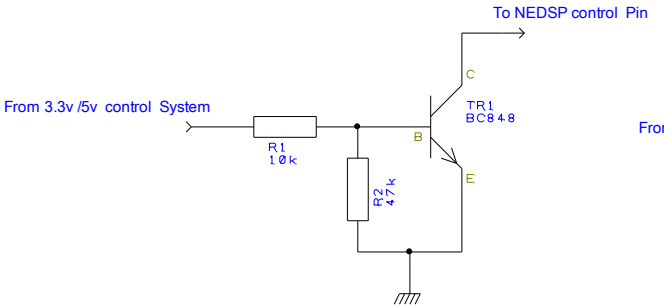
Pin	Signal	Comments
1	Channel 2 – Suppression ON/OFF	Weak Pull-up – Pull Down to Activate
2	Channel 2 – Suppression LSB (NS0)	Weak Pull-up – Pull Down to Activate
3	Channel 2 – Suppression (NS1)	Weak Pull-up – Pull Down to Activate
4	Channel 2 – Suppression MSB (NS2)	Weak Pull-up – Pull Down to Activate
5	Channel 1 – Suppression ON/OFF	Weak Pull-up – Pull Down to Activate
6	Channel 1 – Suppression LSB (NS0)	Weak Pull-up – Pull Down to Activate
7	Channel 1 – Suppression (NS1)	Weak Pull-up – Pull Down to Activate
8	Channel 1 – Suppression MSB (NS2)	Weak Pull-up – Pull Down to Activate
9	Gnd	
10	+5v	

You will note from the previous page, that the switches are ON to get the appropriate line to activate. The NEDSP900 provides a weak pull up to its internal power rail of 1.8Volts, therefore when the switch is activated the appropriate pin is taken to ground. The logic is therefore inverted. The fact that the 'weak' pull-up is to the devices' 1.8v internal logic means that caution should be used when attempting to interface with other logic systems operating at 3.3v or 5v.

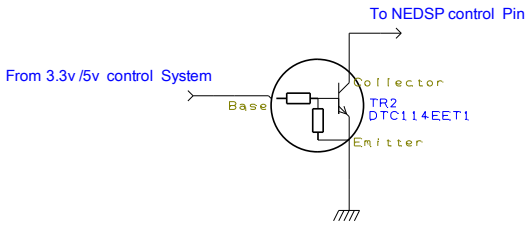
The following are a few suggestions as to the possible methods of implementation

Logic control

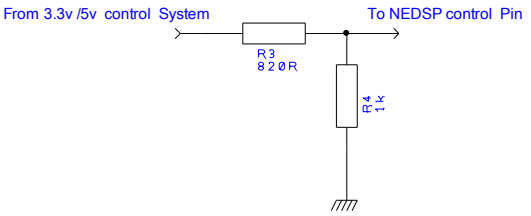
There are several ways in which the module may be controlled by external logic or microprocessor. The various alternatives are shown and described below:



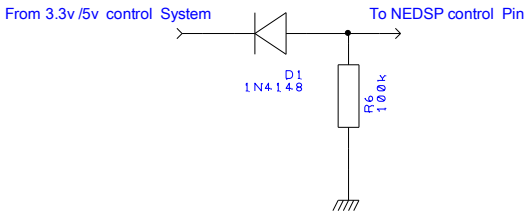
a) Transistor (Logic Inversion) Interface 3.3v or 5.5v



b) Digital Transistor (Logic Inversion) Interface 3.3v or 5.5v



c) Resistor Divider Circuit (see values table)



d) Diode Pull Down Circuit

Circuit a) – This provides a good level conversion interface and has a logic Inversion function, thus a positive logic from the external system will use the transistor as a switch that will pull the NEDSP900 control line down.

Circuit b) – There are many types of what are termed Digital Transistors. These are no more than Circuit a) packaged together in a small surface mount pack. They come in a variety of input and Base to Emitter resistor values. Again these will perform a logical inversion.

Circuit c) – This is the simplest circuit and just provides a simple voltage divider action. Bearing in mind that the NEDSP900 input pins have a maximum of 1.8v voltage limit, you have to be careful with this. The resistors R3 and R4 need to be changed dependent on the control logic voltage being used (3.3v or 5v).

Processor supply	R4 Ohms	R3 Ohms
3.3v	1K	820R
5v	1K	1.8K

There is no logic inversion with this circuit.

Circuit d) - This lets the external control logic pull the NEDSP900 logic down only and the diode becomes back biased when the external logic goes high, leaving the NEDSP900 logic to pull up itself. R6 provides a pull down function to give the Diode something to work against. A value of 100 k Ohms of above is sufficient not to have an

effect on the weak pull up resistance of the NEDSP900. Again there is no logic inversion with this circuit.

6.3 Algorithm 'Hold' (SF)

This is a special facility (SF) that may be useful where this module is incorporated in certain intercom systems (half duplex). As it will be noted from earlier comments in the Noise Reduction section of this document, the DSP algorithm takes a few milliseconds to act on the audio dependent on the noise content. Where the audio content fed into the Module is a 'clean' audio signal, the Noise Reduction algorithm reduces its effectiveness. In certain intercom configurations where there may be bursts of 'clean' audio this can lead to problems and small periods of noisy audio may be heard while the algorithm starts to pick up on the noise content again.

The Algorithm 'Hold' line is marked as S.F. on the module and when activated 'holds' the Noise Reduction algorithm in its last state. When De-activated, the algorithm continues where it left off and effectively reduces or removes periods whereby there may be some Noise content allowed through.

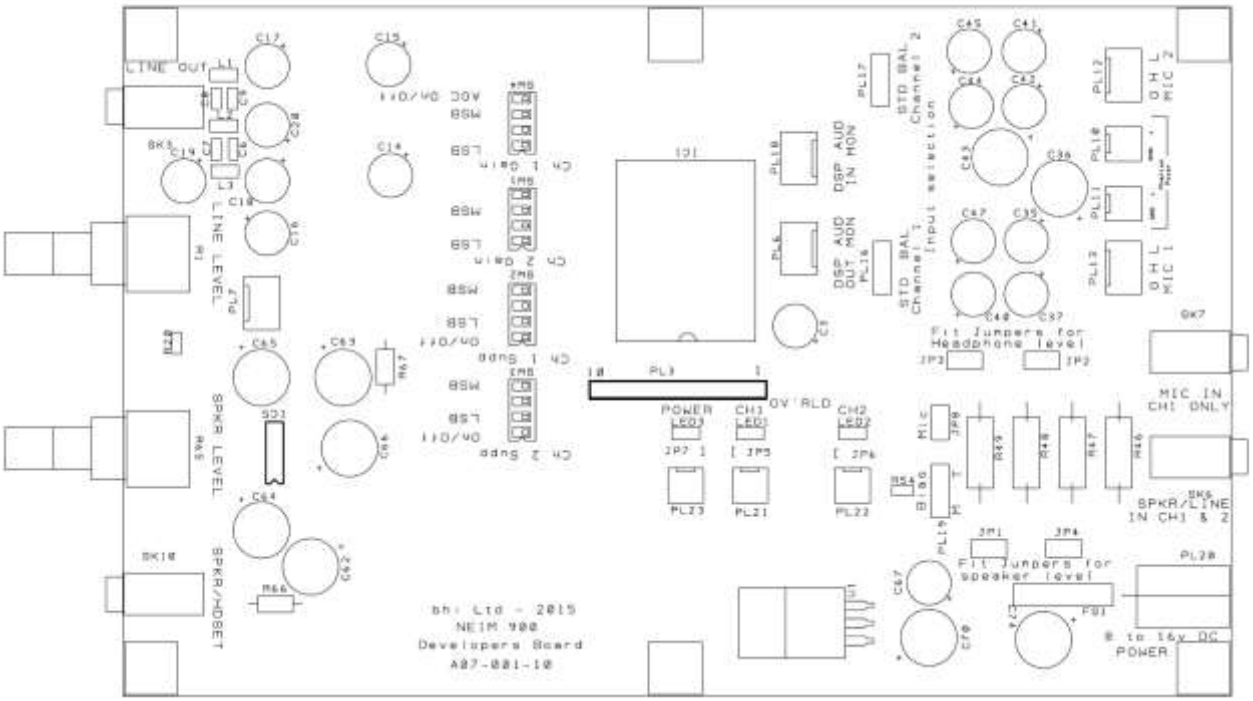
The Algorithm Hold pin is not bought out as an 'off-board' function of PL3, but is available as the MSB of the Audio 2 Gain switch SW1. So placing this switch in the ON position will 'Hold' the algorithm on both audio channels.

7.0 Connector specifications

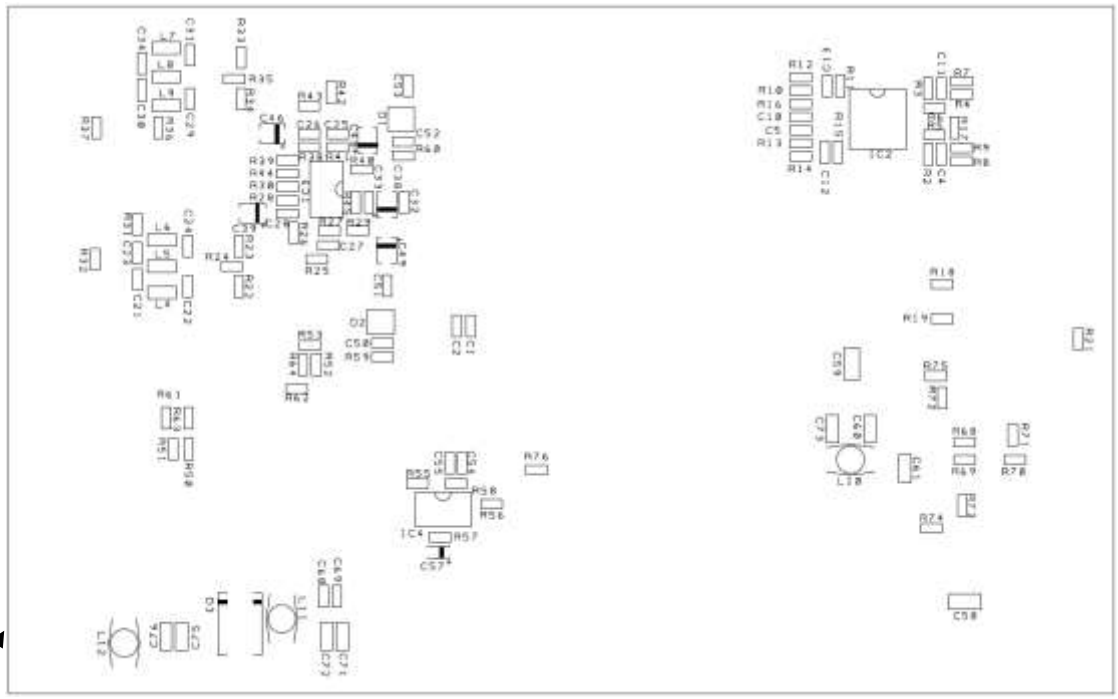
The board has the following connections to facilitate power, signal and control connections. The information is given here such that the user can obtain the correct connectors to interface with these or fit to the PCB

Connection	*Connector Number*	*Detail*	*Comments*
DC	PL20	Standard 2.1mm diameter DC Jack	Centre = +ve DC and Outside = Ground
Speaker/Headphone Input	SK6	3.5mm Stereo Jack Socket	Tip = Channel 1, Ring = Channel 2 and Base = Ground
Mic Only Input	SK7	3.5mm Stereo Jack Socket	Tip = Mic Audio, Ring = Bias and Base = Ground
Balanced Microphone Inputs	PL12/PL13	Any 0.1" standard Wire to PCB connector – 3 Way. Molex KK or similar	Not Fitted, see Appendix A
Balanced Microphone Phantom Power	PL10/PL11	Any 0.1" standard Wire to PCB connector – 2 Way. Molex KK or similar	Not fitted, See Appendix A
Pre/Post DSP audio signal monitor points	PL6/ PL10	Molex 01" KK series – 3 Way connector	Pin 1 = Channel 1, Pin 2 = Ground and Pin 3 = Channel 2
Buffered DSP audio signal monitor	PL7	Molex 01" KK series – 3 Way connector	Pin 1 = Channel 1, Pin 2 = Ground and Pin 3 = Channel 2
Line Out	SK3	3.5mm Stereo Jack Socket	Tip = Channel 1, Ring = Channel 2 and Base = Ground
Speaker/Headphone Out	SK10	3.5mm Stereo Jack Socket	Tip = Channel 1, Ring = Channel 2 and Base = Ground
Control Signals	PL3	Any 0.1" standard single in-line connector – 10 Way. Molex KK or similar.	Not Fitted, see appendix B

Appendix A - PCB Documentation and BOM

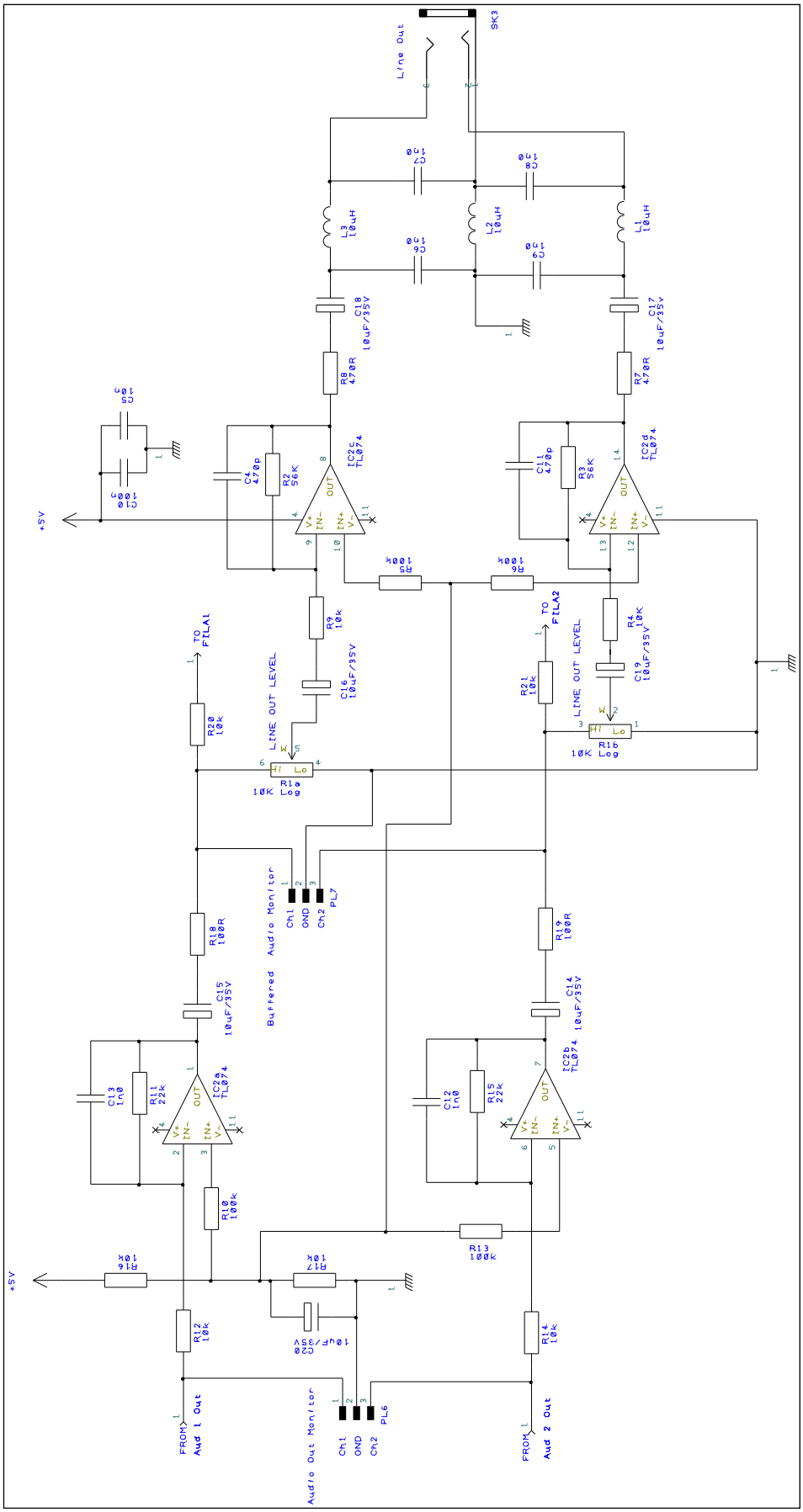


Board Topside Layout

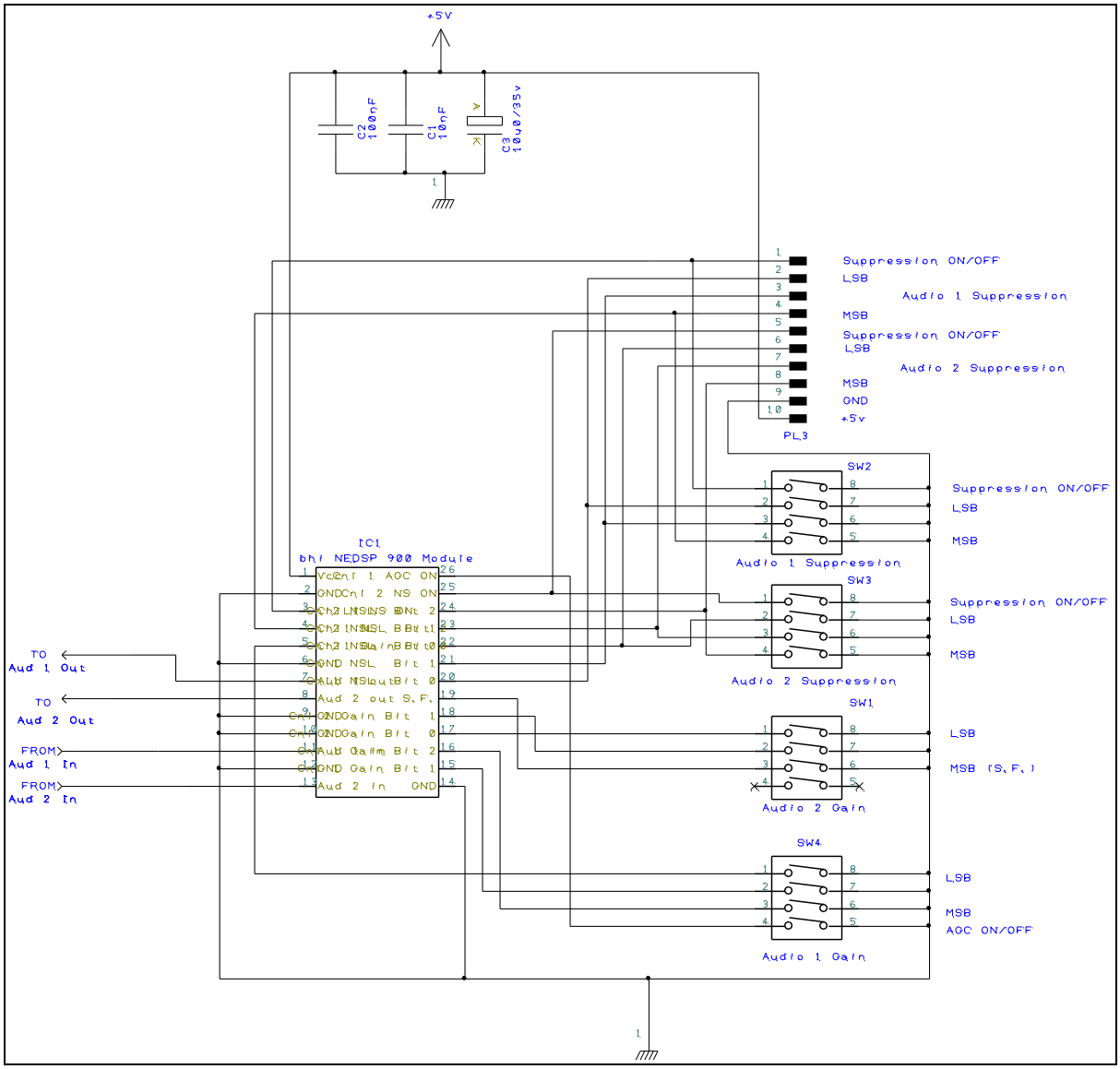


Board Bottom side Layout

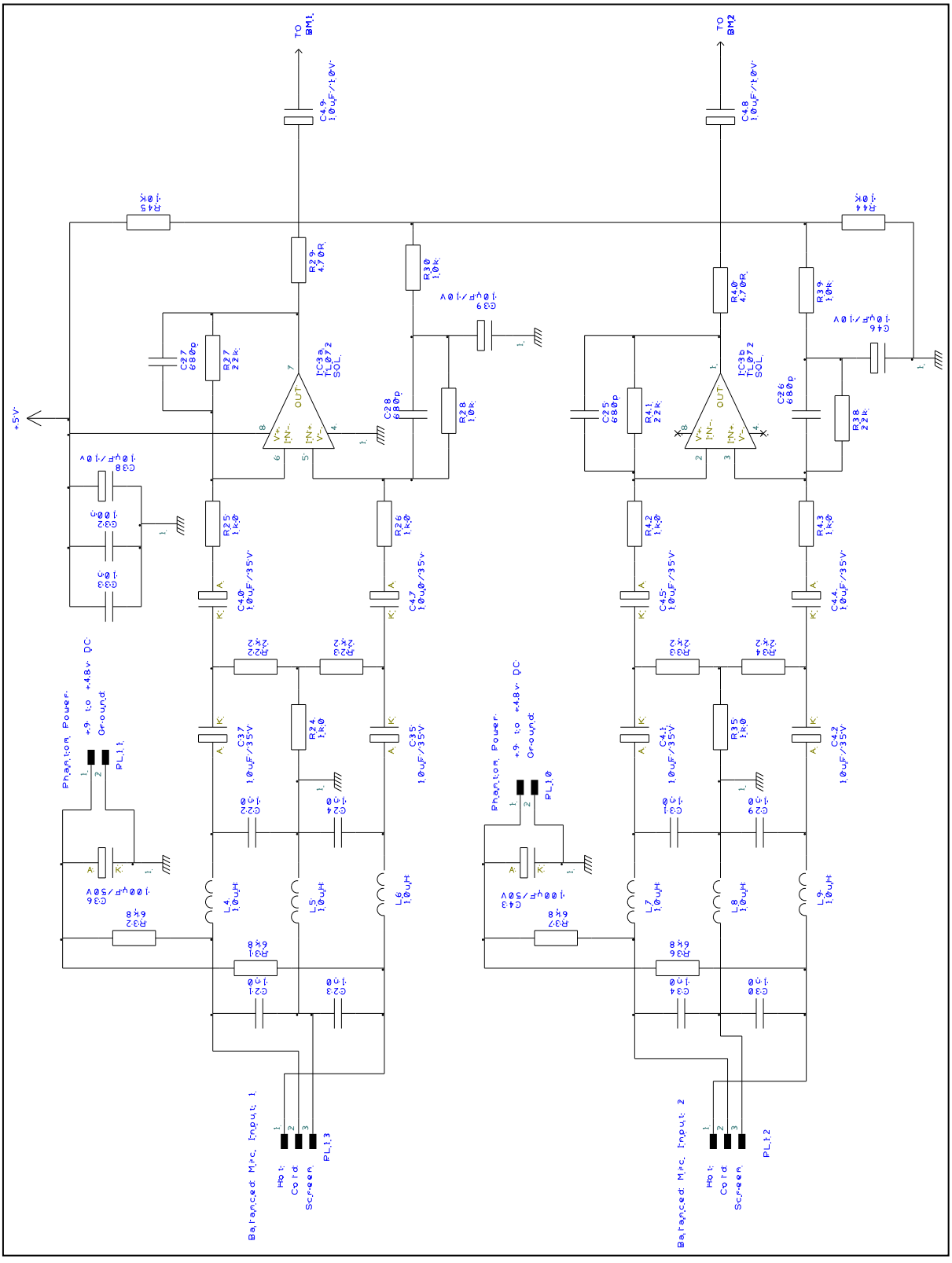
Power Input on this end



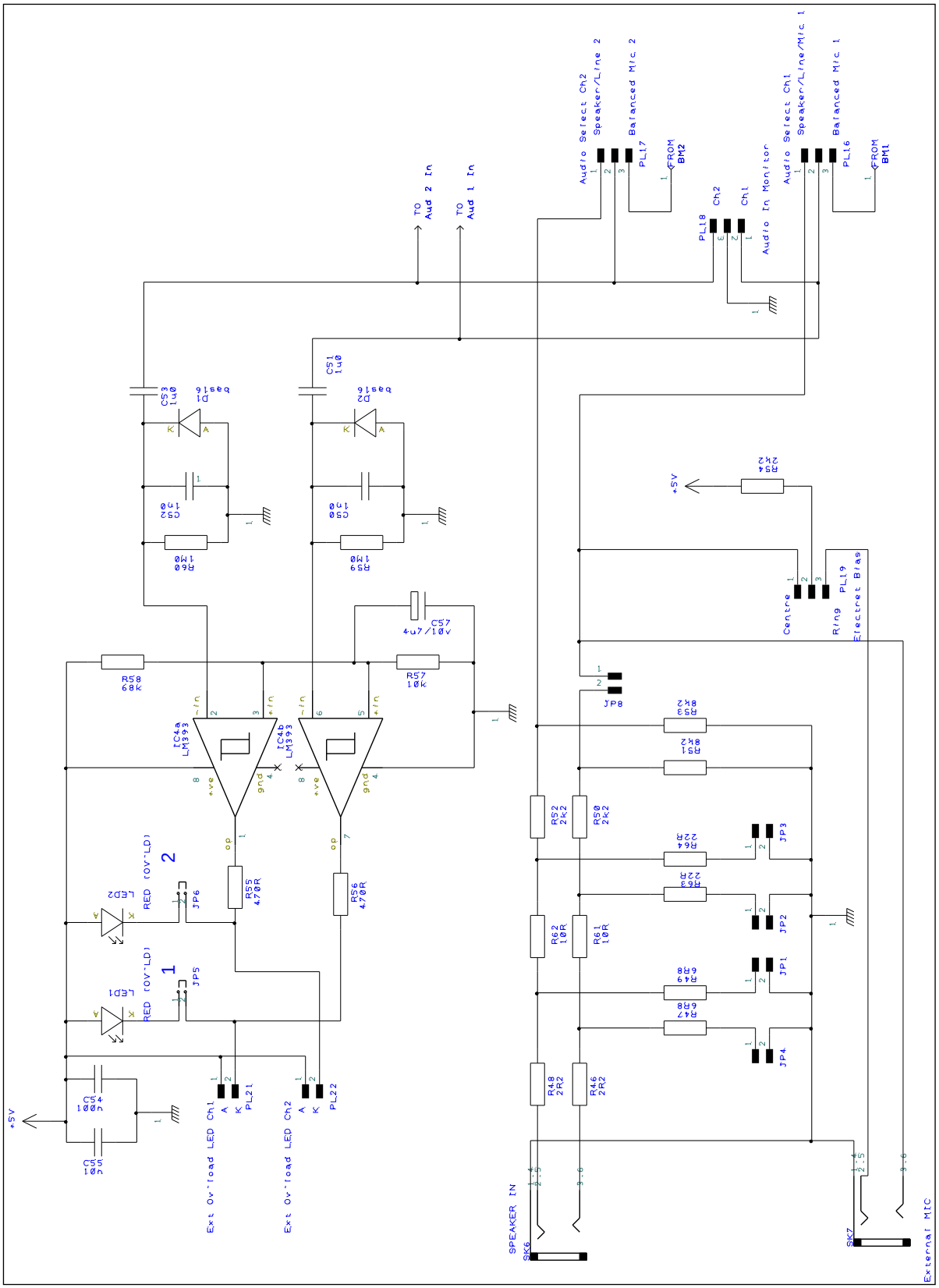
Schematic Diagram Sheet 1 of 5 – Output Buffer and Line Driver



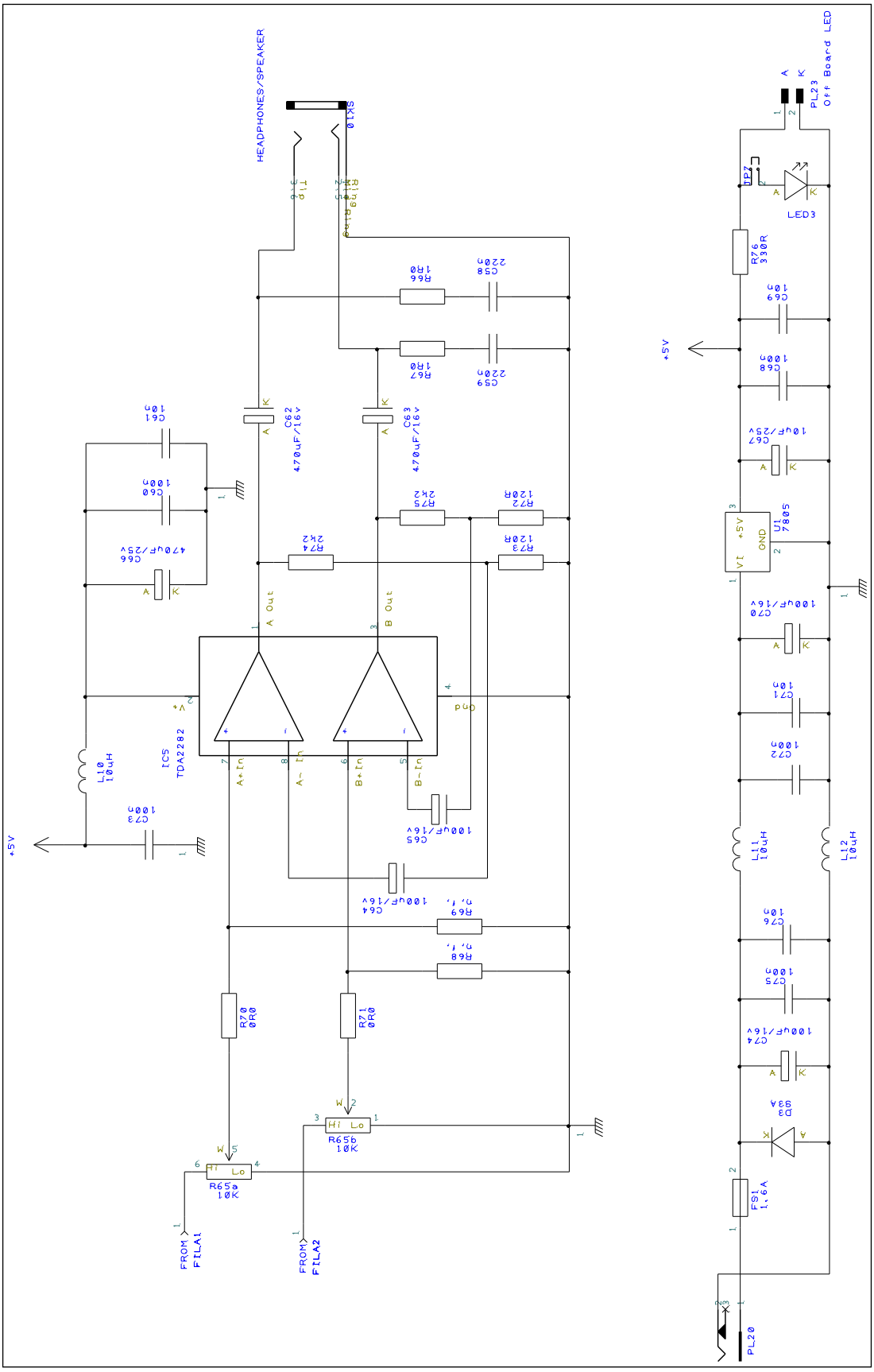
Schematic Diagram Sheet 2 of 5 – NEDSP900 and Control Switches



Schematic Diagram Sheet 3 of 5 – Balanced Audio Inputs (See also Appendix B)



Schematic Diagram Sheet 4 of 5 – Speaker and Microphone Input Interface with Overload Indicator



Schematic Diagram Sheet 5 of 5 – Power Input Filtering and Regulation with Headphone Amplifier

Bill of Materials - BOM

The following is the BOM for the complete PCB (including the Balanced input Amplifiers)

Item	Description	Qty	Part No.	Supplier
Variable Resistors				
R1, R65	ALPS RK12 10K Log	2		Rapid
Resistors Axial				
R66, R67	1R0/ 0.6W Metal Film	2	62-7400	Rapid
R46, R48	2R2/ 2 Watt	2	62-0235	Rapid
R47, R49	6R8/ 2 Watt	2	62-0275	Rapid
Resistors SM 0603 1%				
R68, R69	Not Fitted	2		
R70, R71	0R0	2	933-1662	FEC
R61, R62	10R	2	72-9800	Rapid
R63, R64	22R	2	72-9804	Rapid
R18, R19,	100R	2	72-9816	Rapid
R72, R73	120R	2	72-9817	Rapid
R76	330R	1	72-9824	Rapid
R7, R8, R55, R56	470R	6	72-9826	Rapid
R50, R52, R54, R74, R75	2K2	5	72-9838	Rapid
R51, R53	8k2	2	72-9847	Rapid
R4, R9, R12, R14, R16, R17, R20, R21, R57	10K	9	72-9849	Rapid
R11, R15	22K	2	72-9855	Rapid
R2, R3	62K	2	933-1417	FEC
R58	68K	1	72-9864	Rapid
R5, R6, R10, R13	100K	4	72-9867	Rapid
R59, R60	1M0	2	72-9884	Rapid
Semiconductors SMT				
D1, D2	BAS16	2	47-0832	Rapid
D3	S3A	1	47-2458	Rapid
Integrated Circuits SMT				
IC1	NEDSP900	1	NEDSP900	bhi Ltd
IC2	LM324	1	121-1103	FEC
IC4	LM393M	1	82-0274	Rapid
IC5	TDA2822	1	82-0672	Rapid

Item	Description	Qty	Part No.	Supplier
IC's Through Hole				
U1	DE7805	1	47-3313	Rapid
Inductors SMT High Current				
L10 - L12	10uH	3	182-8172	FEC
Inductors SMT 0805				
L1 - L3	10uH	3	233-3632	FEC
LED's SMD 0805				
LED1, LED2	Red (Kingbright KP-2012IT)	2	72-8560	Rapid
LED3	Grn (Kingbright KP-2012SGT)	1	72-8570	Rapid
Capacitors SMT 1206				
C58, C59	220nF	2	61-5174	Rapid
Capacitors SMT 0805				
C61, C71, C76	10nF	3	71-2014	Rapid
C60, C72, C73, C75	100nF	4	71-1854	Rapid
Capacitors SMT 0603				
C4, C11	330p	2	145-8854	FEC
C6 - C9, C12, C13, C50, C52	1nF	13	71-1834	Rapid
C1, C5, C55, C69	10nF	4	71-1844	Rapid
C2, C10, C54, C68	100nF	4	71-1862	Rapid
C51, C53	1u0/16v	2	71-1868	Rapid
Capacitors Tantalum SMD				
C57	4u7/10v (A)	1	71-4220	Rapid
Electrolytic Capacitors Radial Through Hole				
C3, C14 - C20, C67	10uF/25v (B)	9	11-0220	Rapid
C64, C65, C70, C74	100uF/25v (F)	4	11-2922	Rapid
C62, C63, C66	470uF/16v (G)	3	11-0275	Rapid
Fuse				
FS1	MultiFuse 1.1 A Fuse (MF R110)	1	26-4146	Rapid
Switch				
SW1 - SW4	DIL 4 off SPST Switch	4	80-0334	Rapid

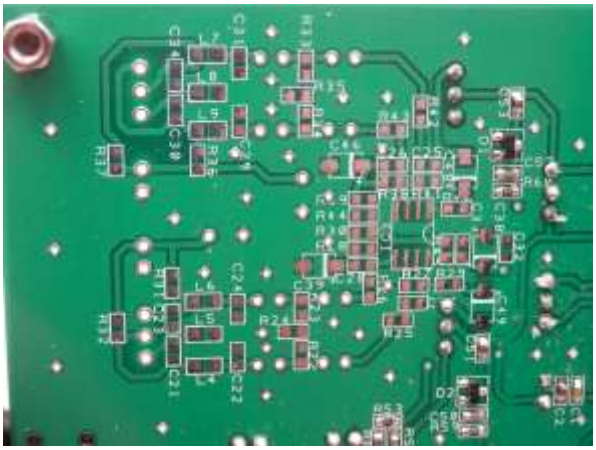
Item	Description	Qty	Part No.	Supplier
Connections				
PL21 - PL23	Molex KK 2 way	5	22-0838	Rapid
PL6, PL7, PL18	Molex KK 3 way	3	22-0840	Rapid
JP1 - JP4, JP8	2 Way Jumper Header	5	54-3943	Rapid
PL16, PL17, PL19	3 Way Jumper headers	3	54-3943	Rapid
Misc.	Jumpers for above	6	22-3555	Rapid
SKT for IC1	13 way 2mm SIL Socket	2	19-0080	Rapid
PL20	2.1 DC Socket	1	20-0970	Rapid
SK3, SK6, SK7, SK10	3.5 mm Stereo Jack socket	4	20-0096	Rapid
Control Knobs	15.5mm Round (6mm Shaft)	2	32-0270	Rapid
Hardware for U1 and Board Support				
	M3x 10 Screw St Stl	1		
	M3Full Hex Nut St Stl	7		
	M3 Plain washers St Stl	7		
	M3 Crinkle Washers St Stl	7		
	M3 x 10 Hex Standoff	6	33-3593	Rapid

Appendix B - Balanced Audio inputs

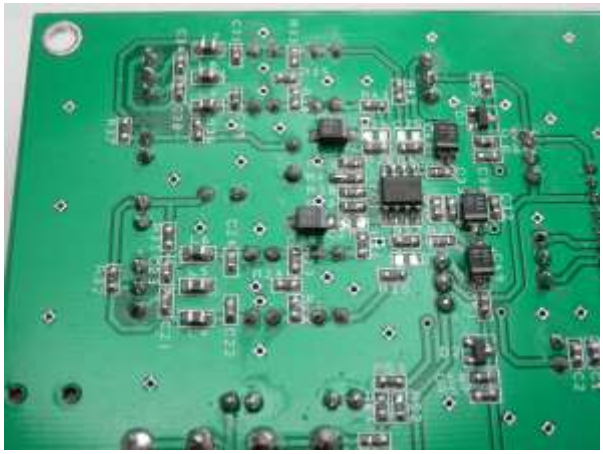
The board has been designed with 2 off balanced input amplifiers, meant for microphones. These are available on the PCB, but require to be populated with components to enable their use. The inputs are carried out using standard Molex KK connectors.

Each Microphone input has the possibility of adding Phantom Power up to 48 volts. This is useful when using professional condenser electret microphones requiring a remote power source.

As standard this section of the PCB is not supplied populated and is left to the user to use this as a 'Breadboard' circuit, choosing their own component values to suit the type of input intended to be used. The circuit shows the values for use with a Magnetic microphone input of around 500 Ohms with an output of around 5 mV P-P. The gain of the circuit has been set to provide around 26dB in order to bring the level up to that commensurate with a standard Electret Insert.



PCB as normally supplied



PCB Populated ready for use

The circuit diagram is given on page 27 with the Bill of Materials thereafter. The PCB component positions can be found in the Board Layouts given on Page 16.

Important: Take appropriate Electro-Static precautions before handling the PCB and while making any additions or changes to the PCB components.

Circuit Explanation

As both circuits are identical, only one circuit Input 1 based around IC3a will be discussed. The information from this can then be read across to the other circuit.

Phantom Power

PL11 allows the application of up to 48 Volts Phantom power to be applied to the balanced signal pins via 6.8K Ohm resistors and referenced to Ground. It goes without saying that C36 provides smoothing for any ripple that may exist on the Phantom supply.

RF Filtering

To improve RF immunity a simple PI-Filter (created by C21, C23, L4 Thru L6, C22 and C24) has been fitted to the front of the circuit, this ensures that all 3 lines have improved RF immunity (even the Ground).

DC Isolation

There are two ways of achieving this, on is to buy expensive Non-Polarised Electrolytic capacitors and the other to use 2 in series back to back (C37, C40, C35 and C47). The latter approach has been taken for cost purposes. In the centre of these serial capacitors is a drain down circuit which not only keep the pre-amplifier stable, but makes sure that the capacitors have a reference point to work against.

Operational Amplifier Gain stage

This uses a standard operational amplifier in its Balanced configuration such that Common Mode Signals. (I.e. Similar signals that are traveling along both of the inputs) are minimised when amplified.

R25 and R26 form the input resistance to the Op-Amp, R27 and R28 are the feedback resistors.

Gain Setting

The circuit diagram shows the R25 and R28 set to 22k Ohms to give around 26dB gain. Calculating for a different gain on say the second balanced input:

Gain = R41/R42 = R38/R43 Note: R42 and R43 need to be the same value and likewise R38 and R41 also need to be the same

Frequency Roll off

If the Gain value is changed, so too will the Frequency roll off given by Capacitors C25 through C28. These just add a 3dB roll off and have initially been calculated to give a corner frequency of around 10 kHz.

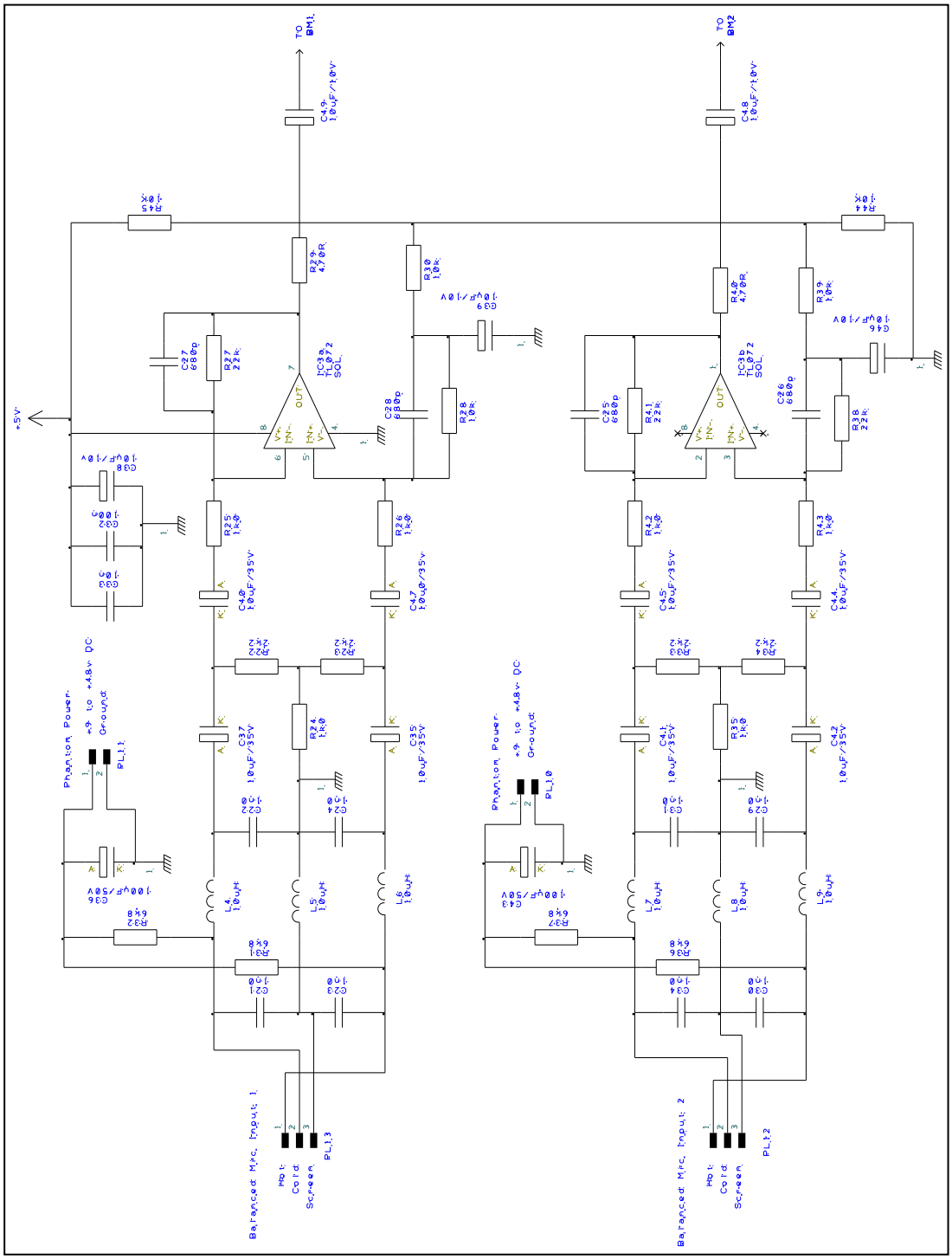
Note: The NEDSP900 DSP has a roll off of around 5 kHz and the circuits that follow have also been tailored to roll off at no more than around 6 kHz.

Output

The output of the Op-Amp IC3a is protected (and stabilised) using R29, with C49 providing DC Isolation for the next stage.

Biasing

As the amplifiers are operating on a single supply rail they have no negative supply and therefore Ground becomes the negative supply, in which case we create a 'false' ground rail by taking the Non-Inverting input (IN +) of the Amplifier components, via R30, to half the rail voltage using R44 and R45. This is a common practice. C39 then ensures that this new reference point is held steady and provides a path for the A.C. signal component to Ground. So the Op- Amp sits with a supply voltage of +5V and is biased such that the output sits as 2.5V. C49 is used to isolate this DC component from the follow on stages.



Schematic Diagram of Balanced Audio Inputs

Bill of Material for Balanced Input amplifiers

Item	Description	Qty	Part No.	Supplier
Resistors SM 0603 1%				
R29, R40,	470R	2	72-9826	Rapid
R24 - R26, R35, R42, R43	1K	4	72-9931	Rapid
R22, R23, R33, R34, R53, R55, R57	2K2	7	72-9838	Rapid
R31, R32, R36, R37	6k8	4	9238581	FEC
R30, R38, R44, R45	10K	4	72-9849	Rapid
R27, R28, R38, R41**	22K	4	72-9855	Rapid
Integrated Circuits SMT				
IC3	LM358ADR	1	752-7007	FEC
Inductors SMT 0805				
L4 - L9	10uH	9	233-3632	FEC
Capacitors SMT 0603				
C25 - C28 **	680p **	4	249-6911	FEC
C21, C24, C29, C30, C31, C34	1nF	6	71-1834	Rapid
Capacitors Tantalum SMD				
C39, C46, C48, C49	10uF/10V (Case B)	4	498-660	FEC
Electrolytic Capacitors Radial Through Hole				
C35 - C37, C40 - C42, C44, C45	100uF, 50V	8	945-1412	FEC
Headers				
PL10, PL11,	Molex KK (22-27-2021) 2 way	2	22-0838	Rapid
PL12, PL13,	Molex KK (22-27-2031) 3 way	2	22-0840	Rapid
Mating Parts for above				
PL10/PL11	Molex KK (22-01-2025) 2 way		20-0820	Rapid
PL12/PL13	Molex KK (22-01-2035) 3 way		22-0840	Rapid
Crimp Pins for above	Crimp Termination 08-50-0032	A.R.	22-0836	Rapid

Note: Components marked ** are Frequency Range/Gain sensitive

Appendix – C
Fitting the board to an enclosure

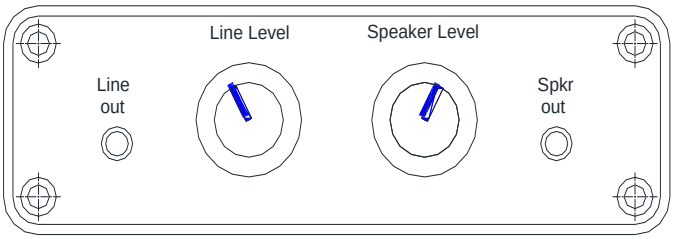
As previously stated this PCB is meant for development purposes only, however, it's understood that in certain circumstances there may be a requirement to turn this stand-alone PCB into a complete unit to be part of an initial system test.

Enclosure

The PCB has been designed such that it can be accommodated into a standard extruded aluminium case (**Hammond manufacturing 1455L1602**). This is not supplied as part of the kit, but may be purchased from most electronic component suppliers.

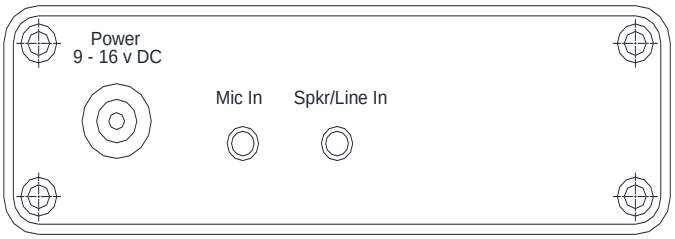
There is a little spare room in this enclosure to accommodate further circuitry, however, if a much larger volume is required the **Hammond Manufacturing 1457N1601** may be used. This gives about double the height which should be more than adequate for a second PCB to be fitted.

The following pages provide some basic machining information to enable the ends of the case to be machined in order to accommodate the PCB.

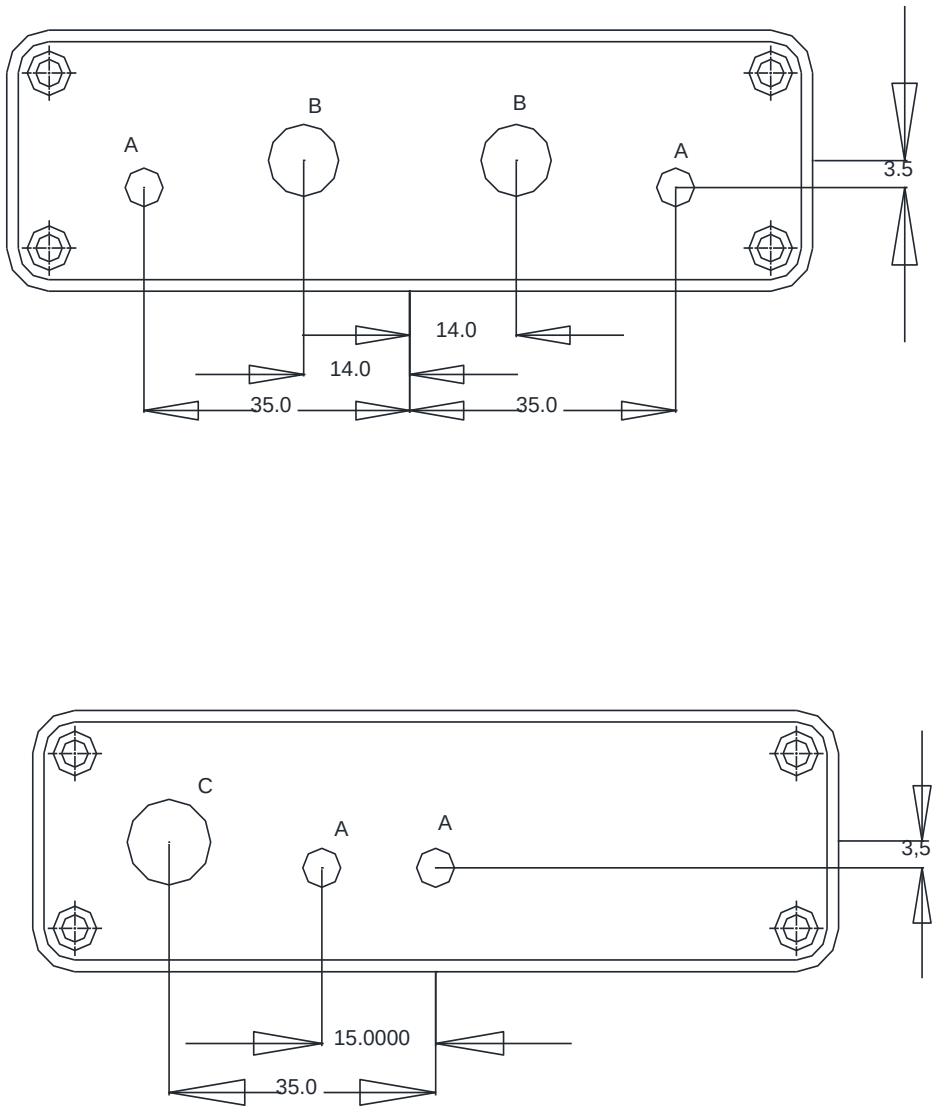


View of front panel showing expected look upon completion.

You will note that indicators such as 'Overload and Power ON' have been omitted as the position of these may depend upon any other circuitry that the user may wish to add.



View of Rear panel showing expected look upon completion.

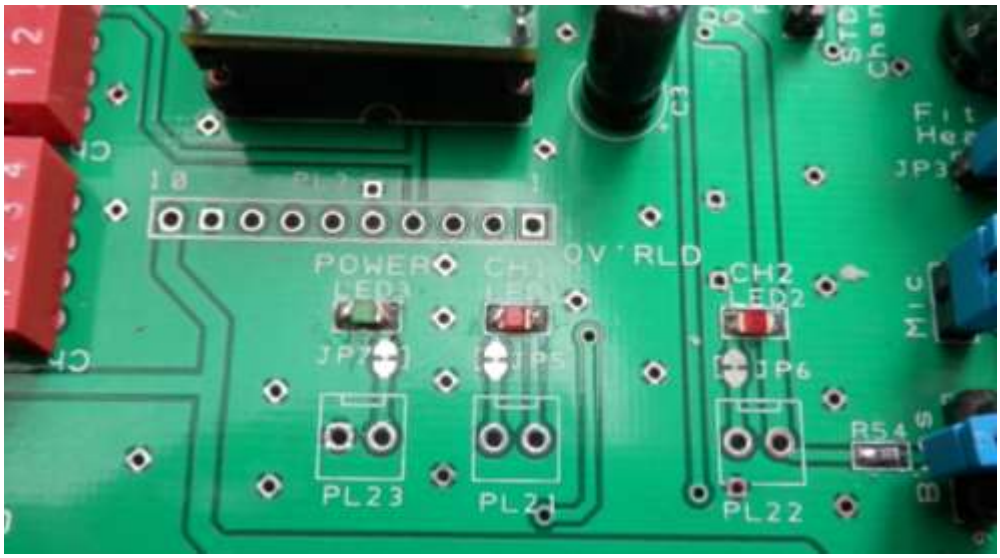


Above – End panel drilling patterns – note that the dimensions should be taken from the centre of the side of each panel.

Note: Positions and sizes of the 'Overload' and 'Power' LED's are left to the user

Preparing the PCB

The indicators are surface mount and therefore little use in the enclosure, however, we have included Header positions PL21, PL22 and PL23 to allow leaded LEDs or wires to be connected to the PCB. The PCB has been designed to use standard Molex KK series headers and receptacles to ease assembly into a case.



You will see that a set of PCB jumper sets JP5, JP6 and JP7 have been provided on the PCB. These need to be cut with a scalpel which will then leave only the headers active.

Suitable interfacing connectors for PL3, PL21 through to PL23 are given in the table below:

Item	Description	Qty	Part Number	Supplier
Headers				
PL21 – PL23	Molex KK (22-27-2021) 2 way	2	22-0838	Rapid
Suitable PL3	Molex KK (22-27-2101) 10 way	1	22-0850	Rapid
Mating Parts for above				
PL21 – PL23	Molex KK (22-01-2025) 2 way		20-0820	Rapid
PL3	Molex KK (22-01-2105) 10 way		22-0832	Rapid
Crimp Pins for above	Crimp Termination 08-50-0032	A.R.	22-0836	Rapid

Front Panel of PCB fitted to Hammond manufacturing 1455L1602 case

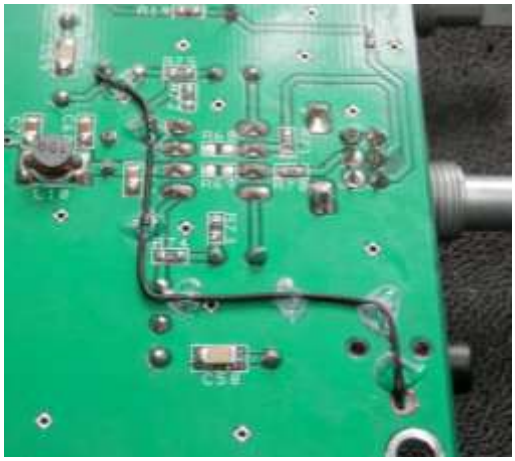
Rear Panel of PCB fitted to Hammond case

Addendum to PCB Model A07-001-10 (Issue:1)

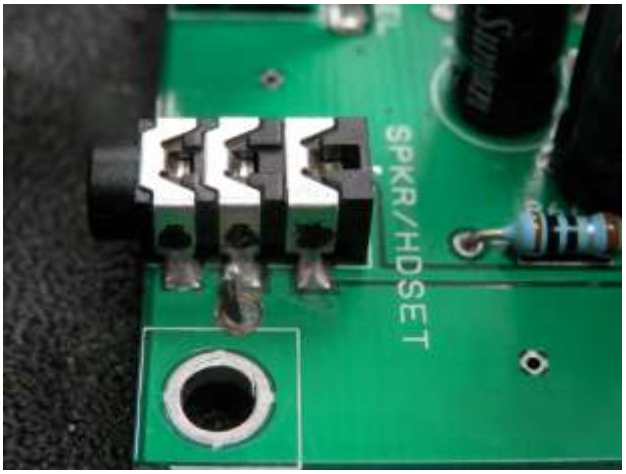
Due to some tracking errors, two traces have been omitted on the PCB.

1. The main omission is of the 2nd audio amplifier output to the Headphone/Speaker socket.

   The affected PCB's have all been modified as shown in the attached pictures below:

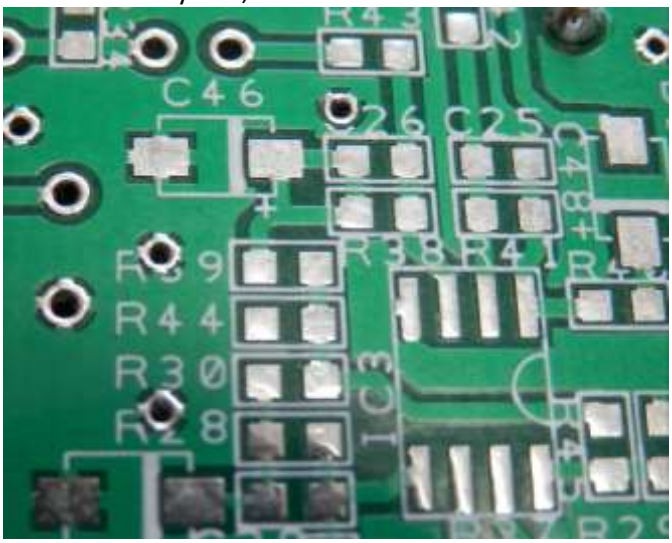


Wiring underside of the PCB



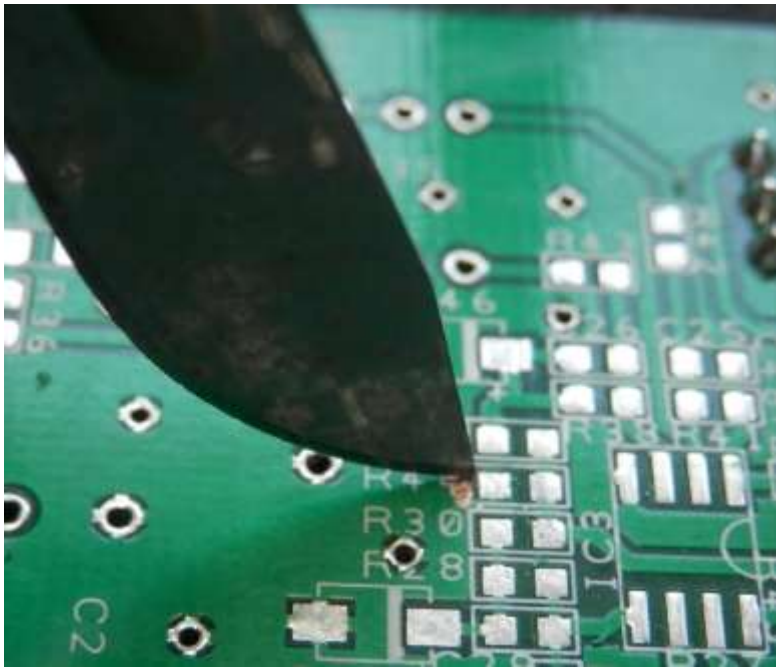
Connection to socket on the topside of the PCB

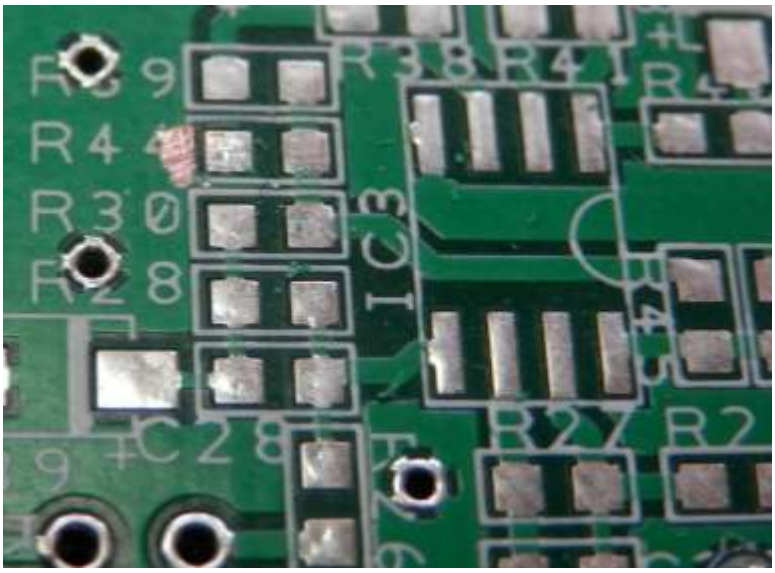
2. **If and only if adding any of the Balanced Microphone amplifier** components and making use of this facility, then the following modification needs to be carried out. This has not been corrected as this needs the appropriate Balanced Input Amplifier components added to the amplifier.
   a. Locate and identify R44, to be found on the bottom end of IC3.



b. Using the tip of a sharp scalpel gently remove the solder resist on the ground area opposite the end of R44.

c.





d. While fitting R44 make sure that the end of the resistor is soldered to the pad and to the area where the Solder Resist has been removed. This completes the update.