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8.3 NEIM1031MKII In-line module.
Then NEIM1031 provides a flexible solution to noise reduction. It features both amplified inputs and outputs, along with line level signal processing. The unit also features an audio bypass when the unit is switched off, so there is no need to disconnect when not in use.

Features:
- Fully adaptive noise cancellation -35dB
- 8 user selectable noise cancellation levels
- Mono earpiece socket
- Input sensitivity control
- Noise cancellation On/Off switch
- Line level in/out
- Input overload indication
- Power on/off with audio bypass.

8.4 NEIM1031 accessories.

8.5 DSP modules.
DSP pcb module range.
NEDSP1061: Low signal level module
NEDSP1062-KBD: Low signal level module controlled by single button keyboard.
NEDSP1062-KBD: Amplified DSP module controlled by a 2 button keyboard.
8. Other bhi products

Other noise cancellation products from bhi. Visit www.bhi-ltd.co.uk for more information.

8.1 NES10-2MKII Noise Eliminating speaker.

DSP noise cancellation built into a compact speaker unit. The unit provides an easy to install solution to noise reduction.

Features:
- Fully adaptive noise cancellation -35dB
- 8 user selectable noise cancellation levels
- Mono earpiece socket
- Input sensitivity control
- Noise cancellation On/Off switch
- LED indication of power and noise cancellation
- 12-24VDC operation
- Compact robust speaker unit.
- Power on/off audio bypass switch
- Easy to install with adjustable mounting bracket
- 2m audio lead
- Optional extras available.

8.2 NES5 Noise Eliminating speaker.

Basic plug and go noise cancelling speaker preset to 20dB of noise reduction.

Features:
- Fully adaptive noise cancellation 20dB
- 12-24VDC operation
- Compact robust speaker unit.
- Greatly improved signal to noise ratio
- Easy to install with adjustable mounting bracket
- 2m audio lead

8. Other bhi products

Other noise cancellation products from bhi. Visit www.bhi-ltd.co.uk for more information.
1. Introduction.

The **NEDSP1062** is a modular solution for noise reduction. It incorporates Digital Signal Processing (DSP) technology to provide up to 35dB of noise cancellation and 65dB of tone reduction. The module features an on-board power amplifier to allow it to be easily incorporated into existing equipment by installing the module in line with the loudspeaker.

1.1 **NEDSP1062 module features:**

- Fully adaptive noise cancellation to 35dB
- Input and output level controls
- Input level overload indication
- Virtually no distortion to speech signal
- Easy to install
- 8 levels of noise reduction
- Frequency response 50Hz - 4.3KHz
- 3 Watts output (4Ω)
- Noise cancellation can be preset or remotely set during operation
- 12 - 18V supply range
- 27dB on board gain
- Wide range of connection possibilities
- Mounting holes
- Audio bypassed when power disconnected
- Small size 37 x 50mm

1.2 **Limitations.**

This module is designed to pass speech. Other signals such as data, music and morse (CW) will to some degree pass through, but the integrity of these signals cannot be guaranteed.

7. Troubleshooting.

7.3 No noise reduction

7.4 Insufficient output volume
1.3 Module connection and mounting

Connections to the module are made by a row of 15 pads at the right hand side of the PCB. These pads are on a 2.54mm (0.1") pitch, which allows the use of standard pin headers, PCB connectors and direct wiring. The heatsink doubles up as a mounting bracket.

The module can be mounted using the supplied self adhesive foam pad. Ensure that none of the circuit pins can make contact with any metallic parts.

For improved heat dissipation and a more rigid mechanical fixing the heatsink can be reversed and used as a bracket. Note that the heatsink is at 0V potential and therefore may have to be electrically insulated from any other metallic parts.

Alternatively the module has four fixing holes which allow it to be fixed to pillars. (See section 6 for hole details and physical dimensions).

Figure 1. Mounting options
1.4 **DSP Noise cancellation.**

The bhi DSP processes the incoming signal and then differentiates the speech from the noise. The unwanted noise and interference is then attenuated to leave only the speech.

The following diagrams are taken from actual audio signals and illustrate how the signal is being processed.

- **Original signal.** Speech with a lot of background noise
- **Processed speech.** Speech with reduced noise

![Figure 3. Noise cancellation.](image)

If the installation has limited space, and is housed in a metal enclosure, the heatsink can be removed, and the module mounted directly in a suitable position. The voltage regulator needs to be correctly insulated as the tab is connected to 0V. Insulate both the regulator and mounting screw. For improved heat dissipation use a suitable thermal paste between the power devices and the mounting.
6. Physical Dimensions

6.1 Physical dimensions.
The following diagrams detail the physical dimensions of the module. All dimensions are in mm.

Figure 22. Mounting hole positions.

2. Module description.

2.1 Block diagram.

Figure 4. NEDSP1062 block diagram
2.2 Module Layout.

The following diagram shows the layout of the NEDSP1062 module.

![Module Layout Diagram](image)

Figure 5. NEDSP1062 connections and controls

Table 1 on the following page gives a description of the pin functions.

The module can be controlled with a microcontroller. As the DSP employs internal pull ups, it is not necessary to drive the microcontroller port pins high, they can be placed in a high impedance state.

![Control Diagram](image)

Figure 20. Control using a microcontroller

The following example employs a 7 segment display and keyboard. Noise on/off is also controlled by the microcontroller. In the diagram 3 buttons are used, up level, down level and DSP on/off.

![Control with Display and Keyboard](image)

Figure 21. Control using a microcontroller with display and keyboard.
5.2 Remote adjustment of noise cancellation level.

This page illustrates various options for altering the DSP level remotely, during operation.

![BCD Complement switch diagram]

**Figure 18. Basic setting using a BCD switch**

The transistors allow interfacing with higher voltages to control the DSP level. These could be replaced by opto couplers for greater isolation.

![Transistor setting diagram]

**Figure 19. Basic setting using transistors**

---

### Table 1. NEDSP1062 connection functions

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Name</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N0</td>
<td>BCD LSB noise cancellation bit</td>
<td>Used to remotely set the DSP filter level. If these pins are used then DCB pin must be set to [5-6] (4-3) &amp; [5-6]</td>
</tr>
<tr>
<td>2</td>
<td>N1</td>
<td>BCD noise cancellation bit</td>
<td>Do not connect</td>
</tr>
<tr>
<td>3</td>
<td>N2</td>
<td>BCD noise cancellation MSB</td>
<td>Do not connect</td>
</tr>
<tr>
<td>4</td>
<td>N3</td>
<td>Supply voltage</td>
<td>Not used</td>
</tr>
<tr>
<td>5</td>
<td>N4</td>
<td>Audio input</td>
<td>Processed audio signal to be processed</td>
</tr>
<tr>
<td>6</td>
<td>N5</td>
<td>Audio output</td>
<td>Audio signal in to be processed</td>
</tr>
<tr>
<td>7</td>
<td>N6</td>
<td>Noise cancellation on/off pin</td>
<td>Connecting this pin to 0V inhibits the noise cancellation. Leave this pin open for noise cancellation.</td>
</tr>
<tr>
<td>8</td>
<td>N7</td>
<td>In</td>
<td>Audio in</td>
</tr>
<tr>
<td>9</td>
<td>N8</td>
<td>Out</td>
<td>Audio input</td>
</tr>
<tr>
<td>10</td>
<td>N10</td>
<td>Agnd</td>
<td>Agnd for input audio signal</td>
</tr>
<tr>
<td>11</td>
<td>N11</td>
<td>0V</td>
<td>0V supply for power on switch if used</td>
</tr>
<tr>
<td>12</td>
<td>N12</td>
<td>5V</td>
<td>5V supply for power on switch if used</td>
</tr>
<tr>
<td>13</td>
<td>N13</td>
<td>On</td>
<td>Logic input for power on switch if used</td>
</tr>
<tr>
<td>14</td>
<td>N14</td>
<td>0V</td>
<td>Logic input from external switch if used</td>
</tr>
<tr>
<td>15</td>
<td>N15</td>
<td>Additional 0V</td>
<td>Spare 0V connection</td>
</tr>
</tbody>
</table>

---

**Figure 20. Circuit diagram**

5. Applications.
2.4 Controls.

The level controls provide adjustment for the audio levels entering and leaving the module. The modules are factory set to the maximum level.

Turning the potentiometers clock wise will decrease the levels. These potentiometers do not have end stops, so it is possible to set them in a position where the audio will be lost.

2.5 Electrical characteristics.

ELECTRICAL CHARACTERISTICS

(V_s=16V, T_amb=25°C unless otherwise stated)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_imp</td>
<td>High level digital output voltage</td>
<td>Is = 0.4mA</td>
<td>V_yp = 0.7</td>
<td>V_yp</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>V_low</td>
<td>Low level digital output voltage</td>
<td>Is = -0.4mA</td>
<td>0</td>
<td>0.2</td>
<td>0.4</td>
<td>V</td>
</tr>
<tr>
<td>I_o</td>
<td>Output leakage current</td>
<td></td>
<td>30</td>
<td></td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>R_o</td>
<td>Output load (digital)</td>
<td></td>
<td>1</td>
<td>20</td>
<td></td>
<td>KΩ</td>
</tr>
<tr>
<td>V_imp</td>
<td>High level input voltage (Scmitt trigger)</td>
<td></td>
<td>3.3</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>V_low</td>
<td>Low level input voltage (Scmitt trigger)</td>
<td></td>
<td>0.8</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>I_imp</td>
<td>Input leakage current</td>
<td>Vin = Vdd</td>
<td>10</td>
<td>-30</td>
<td>-30</td>
<td>-60</td>
</tr>
<tr>
<td>I_low</td>
<td>Vin = 0V</td>
<td></td>
<td>30</td>
<td>-30</td>
<td>-60</td>
<td></td>
</tr>
<tr>
<td>I_on</td>
<td>ON input</td>
<td>Edge triggered</td>
<td>5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
</tbody>
</table>

Table 2. Electrical characteristics 1
Applying 5V to the ON input will alternatively switch the power ON then OFF. This is input is edge triggered, so the pin has to return to 0V before it can accept another latch input. The input is internally debounced to prevent multiple operations is it is driven by a noisy switch.

**Note:**
When the module is in the OFF state it draws a quiescent current of typically 6mA.

The signal to control the power to the module can come from a simple non latching push button, or be driven from external circuitry.

---

**Figure 16. Power switching waveform.**

---

**DC CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_i$</td>
<td>Supply voltage</td>
<td></td>
<td>12</td>
<td>16</td>
<td>18</td>
<td>V</td>
</tr>
<tr>
<td>$k_i$</td>
<td>Quiescent current</td>
<td>$V_i = 12V$</td>
<td>4.6</td>
<td>6.8</td>
<td>8.6</td>
<td>mA</td>
</tr>
<tr>
<td>$k_{i_{DSP}}$</td>
<td>Quiescent current DSP on no load no signal</td>
<td>$V_i = 16V$</td>
<td>143</td>
<td>160</td>
<td>161</td>
<td>mA</td>
</tr>
</tbody>
</table>

**AC CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_o$</td>
<td>Output power</td>
<td>$d = 10%$</td>
<td>12V</td>
<td>18V</td>
<td>18V</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$f = 1kHz$</td>
<td>1.16</td>
<td>1.7</td>
<td>2.06</td>
<td>W</td>
</tr>
<tr>
<td>$V_i$</td>
<td>Input sensitivity 4Ω load</td>
<td>$f = 1kHz$</td>
<td>60</td>
<td>90</td>
<td>130</td>
<td>mV</td>
</tr>
<tr>
<td>$V_i$</td>
<td>Input sensitivity 8Ω load</td>
<td>$f = 1kHz$</td>
<td>81</td>
<td>117</td>
<td>180</td>
<td>mV</td>
</tr>
<tr>
<td>$B$</td>
<td>Frequency response (3dB)</td>
<td>$P_o = 1W$</td>
<td>50</td>
<td></td>
<td>4300</td>
<td>Hz</td>
</tr>
<tr>
<td>$d$</td>
<td>Distortion</td>
<td>$f = 1kHz$</td>
<td>0.8</td>
<td></td>
<td>0.8</td>
<td>%</td>
</tr>
<tr>
<td>$R_i$</td>
<td>Input resistance</td>
<td>$f = 1kHz$</td>
<td>21</td>
<td>22</td>
<td>23</td>
<td>Ω</td>
</tr>
<tr>
<td>$G_v$</td>
<td>Voltage gain</td>
<td></td>
<td>27</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>$n$</td>
<td>Efficiency</td>
<td></td>
<td>33</td>
<td>39</td>
<td></td>
<td>%</td>
</tr>
</tbody>
</table>

**ANALOGUE CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_s$</td>
<td>System delay</td>
<td></td>
<td>26</td>
<td></td>
<td></td>
<td>ms</td>
</tr>
</tbody>
</table>

**Table 3. Electrical characteristics 2**
4.5 Power On/Off.

The NEDSP1062 features a relay to remove the power from the module and at the same time bypass the audio signal. This isolates the module from the target system. This relay can be controlled in 2 ways.

4.5.1 Module powers up with PSU.
The module can power up from the power supply and will connect the audio signal through the module. When the power is removed (or fails) the audio will bypass the module. Ensure that JP1 is fitted. J1 is located near the black relay, in the top righthand corner of the module.

4.5.2 On/Off button.
The module has a latch input that allows it to be controlled by a single momentary push button or external logic signal. Remove jumper J1 from the PCB.

Figure 14. Jumper J1.

Figure 15. Examples of external power switching.
### Table 6. Remote DSP level setting.

<table>
<thead>
<tr>
<th>Level</th>
<th>N2</th>
<th>N1</th>
<th>N0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0V</td>
<td>0V</td>
<td>0V</td>
</tr>
<tr>
<td>2</td>
<td>0V</td>
<td>0V</td>
<td>3.3V</td>
</tr>
<tr>
<td>3</td>
<td>0V</td>
<td>3.3V</td>
<td>0V</td>
</tr>
<tr>
<td>4</td>
<td>0V</td>
<td>3.3V</td>
<td>3.3V</td>
</tr>
<tr>
<td>5</td>
<td>3.3V</td>
<td>0V</td>
<td>0V</td>
</tr>
<tr>
<td>6</td>
<td>3.3V</td>
<td>0V</td>
<td>3.3V</td>
</tr>
<tr>
<td>7</td>
<td>3.3V</td>
<td>3.3V</td>
<td>0V</td>
</tr>
<tr>
<td>8</td>
<td>3.3V</td>
<td>3.3V</td>
<td>3.3V</td>
</tr>
</tbody>
</table>

**Note:**
The DSP has internal pull ups on its inputs, so any cell in the table containing 3.3V may be left open circuit. When processing signals with high levels of noise and high levels of noise cancellation, the signal may sound slightly strange. This is quite normal with this type of signal.

#### 4.4 Noise Cancellation On/Off
The module has the provision for remotely enabling and disabling the noise cancellation, while in operation. The default setting for the module is noise cancellation on. This may be switched by the use of the noise cancellation on/off pin (PCB pin 8).

To inhibit noise cancellation, connect this pin to 0V. To enable noise cancellation leave the pin unconnected.

---

**Figure 8. Sensitivity.**

- \( V_s = 16V \)
- \( f = 1KHz \)
- \( R_L = 8\Omega \)
- \( R_L = 4\Omega \)
3. Installation

3.1 Installation overview.

The NEDSP1062 module is inserted into the path of noisy audio. The input and output level controls allow the module to be fine tuned to suit most applications.

![Basic connection diagram](image)

Figure 9. Basic connection diagram

The input to the module is loaded at 22Ω to provide a dummy load to the preceding circuit. This can be removed if required, such as using the module in applications where the audio source is provided by a low level, low power signal source. More information on this can be found in section 3.3 in this operating manual.

If \( V_{in} \) is less than approx. 13.8V ensure the power supply is well decoupled otherwise the power supply rejection ratio will deteriorate. Best results are obtained in the range of 13.8V - 16Vdc.

4.3 Remote setting of DSP filter level.

Remote setting of the DSP level can also be achieved through PCB connections on J3. This allows the DSP filter level to be changed during operation. If remote DSP setting is used, remove the jumpers from J5 on the module or set them into the OFF position by placing them over one pin on the jumper.

These connections are connected directly to the DSP, do not apply voltages greater than 3.3V to these pins.

To set the DSP level remotely connect the pins N0, N1 and N2 (J3 pins 1, 2, and 3) as shown on the following page.

<table>
<thead>
<tr>
<th>Level</th>
<th>J5 (5 - 6)</th>
<th>J5 (3- 4)</th>
<th>J5 (1- 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>On</td>
<td>On</td>
<td>On</td>
</tr>
<tr>
<td>2</td>
<td>On</td>
<td>On</td>
<td>Off</td>
</tr>
<tr>
<td>3</td>
<td>On</td>
<td>Off</td>
<td>On</td>
</tr>
<tr>
<td>4</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
</tr>
<tr>
<td>5</td>
<td>Off</td>
<td>Off</td>
<td>On</td>
</tr>
<tr>
<td>6</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
</tr>
<tr>
<td>7</td>
<td>Off</td>
<td>Off</td>
<td>On</td>
</tr>
<tr>
<td>8</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
</tr>
</tbody>
</table>

Table 5. Preset DSP levels using on board jumpers.
4. Functions.

4.1 Noise reduction levels.

8 levels of noise reduction are available. The amount of noise and tone reduction is shown in the table below.

<table>
<thead>
<tr>
<th>Level</th>
<th>Tone Reduction</th>
<th>White Noise Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4dB</td>
<td>9dB</td>
</tr>
<tr>
<td>2</td>
<td>5dB</td>
<td>11dB</td>
</tr>
<tr>
<td>3</td>
<td>6dB</td>
<td>13dB</td>
</tr>
<tr>
<td>4</td>
<td>8dB</td>
<td>15dB</td>
</tr>
<tr>
<td>5</td>
<td>16dB</td>
<td>17dB</td>
</tr>
<tr>
<td>6</td>
<td>21dB</td>
<td>20dB</td>
</tr>
<tr>
<td>7</td>
<td>25dB</td>
<td>24dB</td>
</tr>
<tr>
<td>8</td>
<td>65dB</td>
<td>35dB</td>
</tr>
</tbody>
</table>

Table 4. Tone and noise reduction levels.

The DSP level is set by 3 jumpers. This is identified as J5 on the circuit board. When the jumper is placed over the two pins the jumper is ON. When the jumper is connected to one pin only, or removed from the board it is OFF. To reduce the risk of losing the jumper it is advised to place it on one pin when using the OFF position.

3.2 Module setup.

Both the input and output levels are adjustable on the module. This allows easy integration into the target system.

3.2.1 Overview.

To obtain the best results from the noise reduction the module should be set up with the maximum input level and the minimum output level.

The input sensitivity control has a range of 0.70mW - 3W to provide 2W output.

Under certain conditions the DSP can create a small amount of noise, normally when the unit has no signal applied. You should not be able to hear this noise when a signal is applied.

3.2.2 Suggested set up procedure:

Basic setup procedure.
- Connect input source and output device.
- Ensure the NEDSP1062 is switched off.
- Set the audio source to a typical audio level.
- Switch on the NEDSP1062.
- Adjust the input control (P2) until the overload LED illuminates. Reduce the level by approx. 1/4 turn.
- Adjust the output level to the desired level.

It should be possible to set all the levels such that when the module is switched on and off, there isn’t a significant change in the audio level.
3.2.3 Change to output load.

The audio input to the module is loaded at 22Ω. This load is effectively connected across the output load when the unit is switched off (bypassed). This will reduce the impedance presented to the audio source.

For example:
8Ω will reduce to 5.9Ω
4Ω will reduce to 3.4Ω

Figures 10. Input circuit - module powered down

3.2.4 Other signal considerations.

The NEDSP1062 requires a signal of 125mV rms or greater for optimum performance. Signals lower than this may be used but the noise cancellation performance will decrease, as the signal levels drops. If the unit is used with low level signals such as microphones, the signal will need amplifying before applying it to the NEDSP1062.

Due to the adaptive nature of the noise cancellation a small delay may be heard when the audio signal changes. For optimum performance provide the module with a constant signal where possible.

When switching on the unit a thump maybe heard in the loudspeaker.

3.3 Driving from a low signal source.

The input to the module has a low impedance. This is to provide correct loading to any power circuits driving it. If the module needs to be driven from a low power signal then it must be modified in the following manner.

Figures 11. Physical modification for low power signal drive.