



## Models N7FS, N8FS, and N8HFS Matching networks operating guide



**WARNING: OPERATION OF THE MATCHING NETWORK IS SAFE WHEN THE INSTRUCTIONS IN THIS MANUAL ARE READ THOROUGHLY BEFORE THIS SYSTEM IS CONNECTED TO THE POWER AMPLIFIER AND SHAKER. PARTICULAR ATTENTION MUST BE PAID TO THE SAFETY SECTION OF THIS MANUAL. IT IS THE ULTIMATE RESPONSIBILITY OF THE USER TO SAFELY SET UP, OPERATE AND MAINTAIN THE SYSTEM. REPLACE FUSES ONLY WITH THE SAME TYPE AND RATING AS INDICATED. WARNING: TO PREVENT FIRE OR SHOCK HAZARD, DO NOT EXPOSE THIS EQUIPMENT TO RAIN OR MOISTURE.**

**WARNING: LETHAL VOLTAGES ARE PRESENT IN THE AMPLIFIER AND MATCHING NETWORKS.**

## Safety section

The matching network can be safely operated when the instructions in this manual are carefully followed.

This section summarizes the safety considerations. Reminders, in the form described below, will appear in the detailed instructions to assure operator awareness of these safety considerations. Qualified personnel should operate and maintain this power amplifier only after becoming thoroughly familiar with this manual.



**WARNING:** This symbol is used in the instruction manual where operator safety must be considered. The instruction manual should be consulted and read carefully.



**CAUTION:** This symbol is used when caution is needed to prevent damage to equipment. It is used where careful attention to certain procedures described in the instruction manual is needed. This symbol is also used to emphasize procedures other than normal operating procedures.



## **Safety summary**

1. Make sure that the power amplifier is properly grounded to a good earth ground.
2. Make sure that any piezoelectric shaker being driven is properly grounded to a good earth ground.
3. Disconnect the power cord at its source before connecting or removing any cables.
4. To reduce the risk of electric shock, do not remove the power amplifier cover. No user-serviceable parts are inside. Refer all servicing issues to Wilcoxon Sensing Technologies.
5. Do not attempt to operate a power amplifier without the protective covers secured.
6. All cables must be connected between the power amplifier, matching network and shaker before electrical power is connected. Inspect for frayed or cut cables prior to operation.
7. Wear hearing protection when driving piezoelectric shakers at high levels and high frequencies.
8. Do not expose this equipment to rain or moisture.
9. Lethal high voltage may be present at any of the equipment connectors.
10. The Wilcoxon Sensing Technologies model D125L piezoelectric shaker requires pressurization (minimum 1800 PSI) from a source of dry, inert gas. The shaker must be electrically connected to the matching network and power amplifier, or the shaker terminals should be shorted together, prior to pressurization or de-pressurization. Pressure must be applied or released slowly (1 minute) to prevent excessive voltages at the shaker connecting terminals. Use extreme caution when handling pressurized cylinders.
11. Use common sense and avoid haste!



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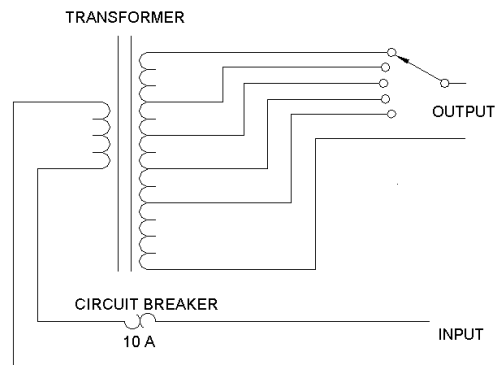
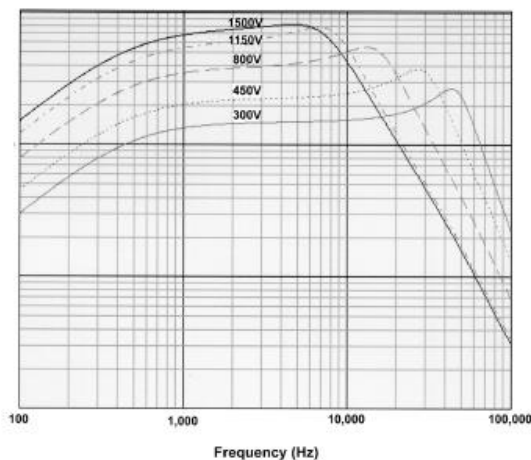


## 1.0 Matching networks operation

While an electromagnetic shaker presents a low, relatively constant, largely resistive impedance, a piezoelectric shaker is essentially capacitive. This means that the impedance presented by the piezoshaker will decrease almost linearly with increasing frequency. A piezoshaker creates a displacement proportional to the voltage input for frequencies below its resonance, therefore, in order to get maximum displacement and consequently maximum acceleration levels at low frequencies the voltage must be stepped up significantly.

**Note:** If a constant voltage (i.e. constant displacement) independent of frequency is generated then the acceleration and force outputs will increase with the square (i.e. at 40dB per decade) of the frequency up to the resonance of the piezoshaker.

The impedance matching network normally consists of a step-up transformer, and an output tap switching arrangement. A variety of output voltages are then available to maximize the voltage delivered to the piezoshaker at different frequencies. Due to the capacitive nature of the piezoelectric shaker, the output impedance of the power amp, and the impedance transformation of the matching network's transformer, the voltage at the piezoelectric shaker rolls off at 20dB per decade after the corner frequency (exactly like an RC filter). As the voltage switch setting on the matching network is switched from its highest to lowest setting the bandwidth of the system will increase.



*Matching Network - Simplified Schematic*

This plot illustrates the output voltage variation of the N8FS matching network as the frequency of the signal varies. The plot was produced by holding the input voltage amplitude of the signal to the N8FS constant at 30 Volts peak. The output of the N8FS was driving a load capacitance of 40 nF (nanofarads), the equivalent of the Wilcoxon D125L shaker. Smaller shakers will have the above-resonance roll-off move higher in frequency (to the right) on this plot since they have lower capacitance. The multiple plot curves illustrate the output voltage variation for each of the transformer tap selections of the N8FS. The N7FS curves will be similar in nature to the ones shown for the N8FS.



In general, the piezoshaker can be operated at their lower frequencies with the matching network switch in its highest voltage position. The relatively low load (high impedance) of the piezoshaker at low frequencies is not demanding and the power amplifier can maintain the high voltage swing for maximum shaker output, however as the operating frequency increases, lower output voltage taps become more efficient. The greatest power requirements for the power amplifier will occur at the corner frequencies of the matching network and shaker system and at the resonant frequency of the shaker.



**CAUTION:** The piezoshakers can be damaged by internal heat build-up when run at high levels for extended periods. This is due to the dielectric loss tangent of the piezoceramic material that generates heat. When driven at high power levels this heat buildup will raise the temperature of the piezoceramic to the Curie temperature where it will depolarize itself. Please contact Wilcoxon for assistance when extended high output testing will be performed.



**CAUTION:** Do not change switch settings when there is a signal present as this may cause the contacts to arc and destroy the switch.

The N7FS matching network connects to the power amplifier and provides selectable maximum voltage outputs of 100, 200, 300, 500, and 800 Vrms. The N7FS matching network is designed to power the model F7 piezoelectric shaker.

The N8FS matching network connects to the power amplifier and provides selectable voltage outputs of 300, 450, 800, 1150, and 1500 Vrms. The N8FS matching network is designed to power the models D60L, D60H, or D125L piezoelectric shaker.

The N8HFS matching network connects to the power amplifier and provides a maximum voltage output of 360 Vrms. The N8HFS matching network is designed to power the F7-1 piezoelectric shaker.

## 2.0 Product description

### 2.1 Front panel

The output voltage selector switch on the front panel selects the appropriate taps of the impedance matching transformer to provide the maximum output voltage as marked on the panel. (Note: The N8HFS has a fixed output voltage).



**CAUTION:** To prevent arcing at the switch contacts, input voltage to the amplifier should always be reduced before the Output Voltage Selector Switch is operated.

### 2.2 Rear panel

The input and output connectors are mounted on the rear panel. Refer to the specification sheet for specific input and output connector types. Also provided on the rear panel is a green banana jack for safety ground connections. This ground connection is only valid when the matching network is connected to a properly grounded Wilcoxon power amplifier.



**Note:** When the PA8HF is used to drive the D125L piezoelectric shaker, the shaker requires proper pressurization (minimum 1800 PSI) from a source of dry inert gas. The shaker terminals should be shorted together, prior to pressurization or de-pressurization. Pressure must be applied or released slowly (1 minute) to prevent build-up of large voltages on the shaker. Use extreme caution when handling high pressure cylinders.

The PA8HF power amplifier is a single-channel power amplifier. A high pass filter is built into the power amplifier to protect it from low frequency overload damage. The power amplifier provides a piezofilter switch on the rear panel. The high pass filter has a  $-3$  dB point of 0.5 Hz with piezofilter “OUT” and 500 Hz with piezofilter “IN”. Piezofilter “IN” position is required when driving piezoelectric shakers since their reactive load characteristics can cause damage below 500 Hz.



**CAUTION:** The impedance matching transformer inside the matching networks appear to the amplifier as a short circuit at low frequencies. The piezofilter prevents the amplifier from trying to drive the matching transformer at low frequencies. If the piezofilter is not used, amplifier and transformer overheating or damage may result.

## 3.0 Installation

### 3.1 System components

In order to operate a shaker system, in addition to the power amplifier and matching network, a signal generator is needed to drive the power amplifier. This generator should have an amplitude control so that the desired operating level can be set. If the signal generator does not have an amplitude control, the power amplifier output cannot be controlled.

### 3.2 Accessories

Accessories available from Wilcoxon for this system include power amplifiers, mounting hardware, and cables. Refer to the Wilcoxon Sensing Technologies catalog for product numbers and ordering information.

### 3.3 Installation checklist

This system requires the following steps for complete installation. The steps have a section below with detailed installation instructions. Use the checklist to complete the installation before proceeding to operation instructions (section 4).

#### 3.3.1 Checking components

Upon receipt, carefully unpack and inspect the matching network for any visible signs of damage to switches, connectors, or the case. If there is damage, file a claim with the carrier who transported the instrument. Retain the shipping container and packing material for use in re-shipment as required. If the container is badly damaged, please contact Wilcoxon customer service. Ensure that you have all components of the purchased system.



### 3.3.2 Ensuring proper cabling

Wilcoxon Sensing Technologies has made every effort to make sure you have the cables required to perform your test. The following list will explain the cables you have received. For systems that include components not made by Wilcoxon, please contact customer service to receive help selecting cables. Refer to the shaker manual to connect your system. The following tables give the Wilcoxon cable part numbers.

<u>Cable connection to matching network</u>	<u>Matching network</u>	<u>Cable connection to shaker</u>	<u>Shaker model</u>
R22-22-J9B-5	N7FS	R4-4M-J9-10	F7
R22-22-J9B-5	N8FS	R7-7M-J59-12	D60L
R22-22-J9B-5	N8FS	R7-7M-J59-12	D60H
R22-22-J9B-5	N8FS	Cable is Integral to D125L	D125L
R22-22-J9B-5	N8HFS	R4-4M-J9-10	F7-1

### 3.3.3 Connecting system and electrical wires

The shaker base should be connected to a good earth ground. Make sure that the piezoelectric shaker's redundant ground lead (if provided) is connected to the green banana jack (if provided) on the matching network. The source generator amplitude control should be turned to its minimum setting before the power amplifier is turned off or on.

### 3.3.4 Testing the matching network

With all shaker system components connected correctly, make sure that the circuit breaker on the front panel of the matching network is in the closed position (push button IN). After the matching network output voltage selector switch has been set to minimum, the power amplifier can be turned on and testing can begin.



**CAUTION:** To prevent arcing at the switch contacts, input voltage to the amplifier should always be reduced before the Output Voltage Selector Switch is operated.

To attain greater output from the shaker, higher voltage can be applied by selecting a higher tap on the impedance matching transformer with the output voltage selector switch. As the frequency of operation is increased, it may be necessary to reduce the step-up ratio by means of the selector switch. This enables operation with a better impedance match between power amplifier and piezoelectric shaker. The generator amplitude control should be turned to its minimum setting before changing the output selector.

When tests are completed, turn the source generator amplitude control down, set the matching network selector to the minimum voltage position, and set the power amplifier power switch to off.





## **4.0 Operation**

The vibration generating system is ready for operation only after it has been thoroughly checked for proper electrical connections. The user should have selected a suitable location for the system, preferably in a sound isolated room, since the shaker may generate a considerable amount of sonic output. It is recommended that the operating personnel use hearing protection.

The following steps are suggested for operation of the vibration generating system:

1. Make sure the signal generator control is set for proper signal output (desired frequency and voltage) to the power amplifier.
2. Set the amplitude control of the signal generator to its minimum level.
3. Adjust the matching network output voltage selector switch to the lowest output voltage setting.
4. (Optional, depending on your system configuration.) Turn on the vibration monitoring system consisting of the accelerometer and its associated output-measuring or display instruments.
5. Turn on the signal generator and set its frequency dial to the low end of the desired frequency range of the test sequence.
6. **STAND CLEAR OF THE SHAKER DURING OPERATION.**
7. Set the amplifier power switch to "ON".
8. Slowly increase the setting of the signal generator amplitude control until the shaker generates the desired vibration level or until clipping of the power amplifier output occurs.
9. (Optional, depending on your system configuration.) It is recommended to use the vibration monitoring system to monitor the amplifier output to prevent overdriving the shaker.
10. Continue the test by changing the oscillator frequency dial and adjusting the amplitude control to attain the desired vibration levels.
11. Higher vibration levels can be obtained by turning the signal generator amplitude control to minimum and setting the matching network output voltage selector switch to a higher output voltage setting as required.
12. Proceed as in step 8 and 9 above.
13. When the test sequence is completed, turn down the signal generator amplitude control and set the matching network Output Voltage selector switch to the minimum output voltage position.
14. Set the amplifier power switch to "OFF".

## **5.0 Technical assistance**

### **5.1 Technical assistance**

For technical assistance, please contact Wilcoxon at 301-330-8811, fax to 301-330-8873, or email to [info@wilcoxon.com](mailto:info@wilcoxon.com).

### **5.2 Customer service**

To obtain a return goods authorization number, please contact customer service at 301-330-8811, fax to 301-330-8873 or email [info@wilcoxon.com](mailto:info@wilcoxon.com).