Grommes-Precision

PRECISION AMPLIFIERS BY PRECISION ELECTRONICS

PUBLISHED PRECISION ELECTRONICS
QUALITY COMPONENTS FOR PA SOUND

SPEAKER INSTALLATION

SPEAKER SYSTEMS FOR USE WITH YOUR GROMMES-PRECISION PUBLIC ADDRESS AMPLIFIER

To match the excellent sound reproducing qualities of your GROMMES-PRECISION amplifier, care must be taken that the speakers are properly selected and arranged, and correctly installed.

Instructions contained here should suffice for a variety of conditions encountered in providing good sound coverage.

When confronted with a unique situation, not discussed here, call or write to our engineering department for assistance.

SELECTION

Survey the location to be covered, for choice of speaker(s).

Consider:

1. Basic use of sound system; for voice or music.
2. Space to be covered.
3. Accoustical properties of the area.
4. Sound level requirement.
5. Location of equipment and placement of speakers.

Determine:

1. The type of speakers needed: cone, column or trumpet (horn).
2. The number of speakers needed.
3. The total power consumption of the system (total of all speakers).
4. Impedance match (transformers or no transformers).

Obtain:

The Grommes-Precision amplifier with sufficient power output to match the load. Below are some examples of the power requirement for sample indoor and outdoor installations:

Amplifier Power	Speakers needed for Indoor Installation	Speakers needed for Outdoor Installation
6-10 Watts	Two Cone Speakers	One Trumpet
11-20 Watts	Four Cone Speakers	Two Trumpets
21-30 Watts	Six Cone Speakers	Three Trumpets
31-60 Watts	Ten Cone Speakers	Four Trumpets
61-100 Watts	Twenty Cone Speakers	Ten Trumpets

PLACEMENT

INDOORS — In general, speakers may be placed flat against the wall, or in the corners of a room. Variation from these basic plans is necessary when there are dividing walls, side rooms, booths, balconies, and alcoves. Extra speakers may be required, carefully placed, to eliminate "dead" spots.

OUTDOORS — Direction of sound, and the area to be covered are the main considerations. Directional trumpets are most effective. However, be aware, the sound presure level from a speaker will be cut in half (drop 6 dB) each time the listening distance from the speaker is doubled. Note that larger horns project sound greater distances. Consider also the dispersion pattern of the speaker.

CONNECTION

Transfer of Power:

Impedance matching and phase relation must be considered to provide efficient transfer of power from the amplifier to the speakers. Speakers may be connected in two ways:

1. Connection, from the amplifier directly to the speaker voice coil. This method is used for short runs of wire less than 200 feet in length, and when simple speaker systems with 8 ohm impedances are used. Run as heavy a wire as possible consistent with the requirements. Speaker cable runs of 100 feet or more should be at least a NO. 16 wire. Runs from 50 feet to 100 feet should be NO. 18 wire.

Standard flexible two-conductor line cord is acceptable. For installations where speakers will remain permanently connected to the amplifier, connect the speaker system directly to the speaker output terminals on the rear of amplifier. Fasten one wire, leading to the speaker system, to the "C" (ground) terminal; the other lead to the terminal matching the impedance of the speaker system.

Where the speaker system is to be moved frequently, as in portable systems, use plugs to attach speakers to the amplifier. Most amplifiers have 2 speaker sockets.

2. Connection from the amplifier to the speaker voice coil through a line transformer. Transformers used with speakers far from the amplifier prevent loss of power in the line. Transformers are always

used for larger systems, especially where some speakers are required to produce more wattage than others.

IMPEDANCE MATCHING WITHOUT TRANSFORMERS

The total speaker impedance(s) must match the output impedance of the amplifier for the most efficient transfer of power. Single speakers should be matched as shown in figure 1.

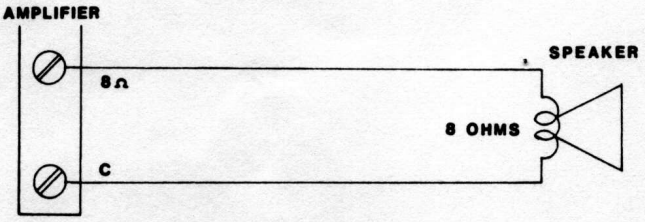


FIGURE 1 MATCHING ONE SPEAKER

1. Speakers Connected in Parallel

$$Z \text{ (impedance in ohms)} = \frac{\text{Voice Coil Impedance of Each Speaker}}{\text{Number of Speakers}} = \frac{8}{2} = 4 \text{ ohms}$$

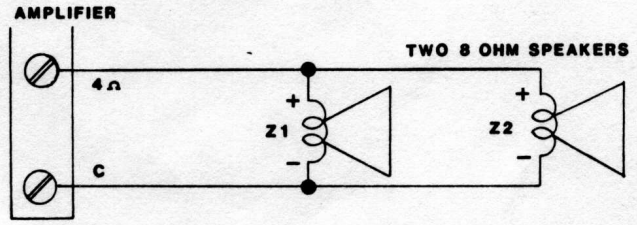


FIGURE 2 MATCHING TWO SPEAKERS IN PARALLEL

2. Speakers Connected in Series

Add the individual speaker impedances to obtain the total matching impedance. (See figure 3)

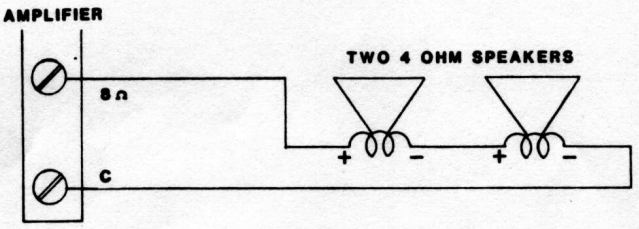


FIGURE 3 MATCHING TWO SPEAKERS IN SERIES

3. Speakers Connected in Series/Parallel

A. Combine the two foregoing formulas as indicated in figure 4. Apply the series formula for Z1 and Z2, then for Z3 and Z4. Take the results of this and apply the parallel formula to obtain the final matching impedance. (See figure 4)

(1) $Z1 + Z2 = 16$

(2) $Z3 + Z4 = 16$

(3) $$Z = \frac{1}{1/16 + 1/16} = 8 \quad \text{or} \quad Z = \frac{16 \times 16}{16 + 16} = 8$$

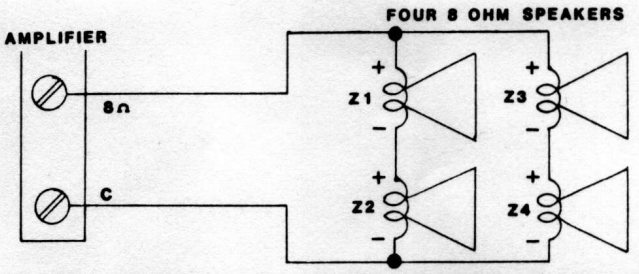


FIGURE 4 MATCHING FOUR SPEAKERS IN SERIES / PARALLEL

POWER DISTRIBUTION WITHOUT TRANSFORMERS

Equal power will be consumed by each speaker in a *series* system where all voice coil impedances are alike. If, however, one speaker has 4 ohms impedance and another 8 ohms, the 8 ohm speaker will consume twice as much power as the 4 ohm speaker.

Equal power will be consumed by each speaker in a *parallel* system where all voice coil impedances are alike. When speakers of different impedances (4 ohms and 8 ohms) are connected in parallel, the 4 ohm speaker will consume twice as much power as the 8 ohm speaker.

IMPEDANCE MATCHING WITH TRANSFORMERS

The impedance matching transformer has been replaced by the 25 volt and 70.7 volt transformer which has taps for watts instead of ohms. This is also called a constant voltage transformer because the voltage at the rated power of the amplifier is the same for all amplifiers regardless of the wattage.

Matching is done by adding up the wattage taps of each transformer connected to the amplifier. The total should not exceed the RMS power rating of the amplifier.

The amount of computation necessary, to determine which are the proper transformer taps to use when varying sound levels are required is greatly reduced by use of the constant voltage method. This method also permits the addition to, or changing of, an existing system without recalculation of the total impedances and the power required.

The total power, consumed by the speakers as a system, must be always less than or equal to the amplifier power rating. (See figure 5)

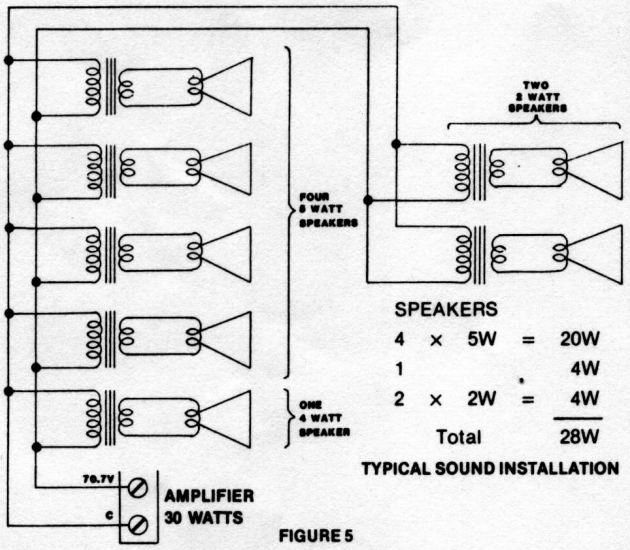
Choosing the Constant Voltage Transformer:

1. Determine the amplifier power output.

2. Determine what power will be supplied to each speaker so that the total power consumed does not exceed the amplifier rating.

3. Select transformers with the required wattage taps and with secondaries which match the speaker voice coil impedances.

4. Use transformers with low insertion loss and sufficient low frequency response to avoid a near short circuit to the amplifier at low frequencies.



TYPICAL SOUND INSTALLATION

FIGURE 5

The wattages shown in Fig. 5 can be converted to impedance in ohms by using the following formula:

$$Z = \frac{E^2}{W}$$

Where: Z = impedance in ohms
E = amplifier output voltage
W = power in watts

Using the 70.7 volt amplifier output tap, E^2 roughly becomes 5,000 and the formula reduces to:

$$\text{Amplifier Impedance} = \frac{5000}{30} = 167 \text{ ohms}$$

Applying the Formula to Each Speaker Transformer:

No. of Speakers	Power to Each Speaker		Required Impedance (Z)
(4)	5 Watts	$\frac{5,000}{5}$	= 1000 ohms
(1)	4 Watts	$\frac{5,000}{4}$	= 1250 ohms
(2)	2 Watts	$\frac{5,000}{2}$	= 2500 ohms

When the 25 volt line is used in place of 70.7 volt line, the following impedances apply:

(4)	5 Watts	$\frac{625}{5}$	= 125 ohms
(1)	4 Watts	$\frac{625}{4}$	= 156 ohms
(2)	2 Watts	$\frac{625}{2}$	= 312 ohms

Once the transformer is selected, connect the secondary to the speaker and then connect the primary taps of all transformers across the 70.7 volt or the 25 volt line, whichever is used.

A group of speakers, at a distance from the amplifier, yet close to each other, can be handled by one transformer. The transformer secondary matches the total impedance of the speaker group.

Speakers at a distance from the amplifier, and also at a distance from each other, require individual matching transformers.

Care should be exercised to match speaker loads correctly. 70 volt lines should never exceed the wattage rating of the amplifier. In some cases it is preferred to match under the rating of the amplifier, especially when transformers with small iron cores are used, as these will approach a near short circuit at low frequencies.

It is highly recommended that the line be checked with an impedance bridge with 400 Hz, 100 Hz, and 50 Hz if possible.

The following is an alternate method for checking a safe impedance match for 70 volt lines. Insert a 1 ohm 5 watt resistor in series with one side of the 70 volt speaker line. Connect an AC voltmeter across the resistor. Operate the amplifier at the volume normally used and note the voltmeter reading. Formula for calculating the wattage is as follows:

Suppose the Meter Reads 1.4 volts

$I = \frac{E}{R}$ or $\frac{1.4}{1} = 1.4$ Amp. Then W = E × I or 70 × 1.4 = 98 Watts

For a 100 watt amplifier the average reading will be 1.414 volts. If it is higher, the match is incorrect and the amplifier is being overloaded. A better test would be to connect a sine wave generator to the amplifier and vary the frequency from 1000 Hz down to 30 or 40 Hz and note the reading.

PHASING OF SPEAKERS

When more than one speaker is mounted in the same general area, connected either in parallel or in series, phasing of the speakers is important. This will prevent loss of up to one-half normal volume of sound, possible with speakers out-of-phase.

Speakers are in-phase when the diaphragms move outward and inward simultaneously.

Phasing is accomplished by checking the polarity of the speaker terminals with respect to the movement of the speaker diaphragm and connecting the terminals from speaker to speaker according to the diaphragm movement or phasing desired.

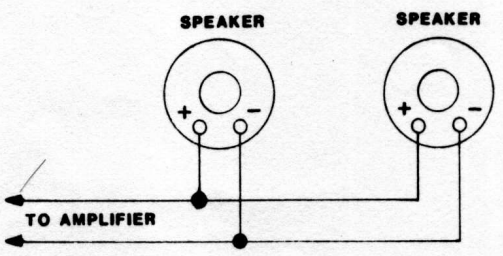


FIGURE 6

Diaphragms of identical speakers should move in the same direction when the same respective terminals on each speaker are used, but it is safer to check the polarity as described as follows:

Where the speakers are not identical, carry out the following procedure to determine the diaphragm movement with respect to the speaker terminals.

1. Connect one lead from a 1.5 volt dry-cell to one voice coil terminal of the speaker.

2. Momentarily touch the other lead from the dry-cell to the other speaker terminal.

3. Observe direction of cone or diaphragm movement (either inward or outward) when the circuit is closed.

4. Record this direction of movement; mark the terminal connected to the positive pole of the dry-cell if the movement is outward; mark the terminal connected to the negative pole if the movement is inward.

5. Repeat steps "1" through "4" for other speaker or speakers to be checked. Then connect the marked and unmarked terminals according to the manner of electrical arrangement desired.

6. In simple sound systems it may be easier to check phasing by listening to music from the system while alternating the leads on one speaker at a time. The ear can usually detect the hook-up which will provide the highest signal volume.

A good sound system must be free from oscillation at very high frequencies which is above 15,000 Hz and beyond the range of human hearing.

Oscillation occurs when speaker lines radiate back into the microphone line. Oscillation will rob the amplifier of its power, cause it to overheat and possibly trip the circuit breaker, blow the transistors or burn out the speaker system.

Oscillation can be confirmed by connecting an oscilloscope or AC meter across the speaker terminals.

The following should help eliminate oscillation problems:

1 - Ground amplifier to a good earth ground.
2 - Keep speaker lines as far away as possible from microphone lines.
3 - Use low impedance microphones and low impedance 2-wire shielded microphone cable. *Do not* ground line at any point except at the amplifier.
4 - *Do not* ground speaker line at any point away from the amplifier.
5 - 70 volt speaker lines should be balanced. *Do not* ground one side of line to amplifier.
6 - When used outdoors *do not* lay speaker and microphone lines on damp or wet ground.
7 - *Do not* use excessive treble boost with the amplifiers' tone control.

COPPER WIRE TABLE

GUAGE	OHMS PER 1000 FT.	OHMS PER 100 FT.	FT. PER OHM
22	16.14	1.6	62
20	10.15	1.0	98.5
18	6.385	0.6	156.5
16	4,016	0.4	249
14	2.525	0.25	396