PRECAUTIONS

To ensure maximum safety, please carefully follow the instructions below:

1. Check the power source
   Plug the unit only into a power source whose voltage and frequency ratings match those given in the instruction manual.

2. Power cord
   The unit is provided with a 3-core type a.c. line cord with a grounding wire. Insert the plug only into a 2 conductor outlet (containing grounding wire) of 120V/60Hz. Or if a 3 conductor outlet is not available, use an adapter, connecting the grounding wire to a grounding screw on a wall, etc. Insert or unplug the a.c. line cord only after making certain that the unit's power switch is turned off, to prevent shock noise from damaging the speakers.

3. Ventilation
   To offset heat generated by the unit, it is necessary to provide ample ventilation around the unit. Avoid blocking or impeding the ventilation holes on the unit. To prevent unnecessary problems, install the unit on a surface free from any vibrations, direct sunlight, humidity or dust circulation.

4. Do not open the cabinet
   The unit has been completely factory adjusted. To avoid electric shock or harm to the human body or to the unit, never open the cabinet.

5. If the unit gets wet or foreign matter enters
   In case the unit gets wet or any water or foreign matter gets into the cabinet, immediately disconnect the a.c. line cord, and consult your dealer or qualified technician.

6. Instruction manual
   Keep the instruction manual near the unit, and record the serial number (found on the rear panel) on the cover.

SWITCHES, CONTROLS AND OPERATION

1. Power Button
   Depress this button to turn on power. Pressing it a second time will turn off power.

2. Power Indicator
   Glows when the power is turned on, indicating that the unit is in operation.

3. BASS/TREBLE Tone Controls
   These are rotary controls that regulate the balance of tone of input signals coming from MICS 1, 2, AUX, or PHONO/TUNER. BASS regulates the low frequency range and TREBLE the high frequency range. Rotate the respective knobs to the right to increase the response, and to the left to decrease it.

4. Microphone Jack (MIC 1)
   An input terminal used to connect a high impedance microphone with a standard type plug to the unit. On the rear panel of the unit are screw type MIC 1 terminals. Since the MIC jack on the front panel takes priority over the rear MIC terminals, the MIC jack on the front panel should not be connected with a microphone plug when the MIC 1 terminals on the rear panel are in use.

5. MIC 1, 2 Level Controls
   These controls regulate the input levels from microphones connected to the respective MIC terminals. Rotate each knob clockwise to raise the input level, and counterclockwise to reduce it. Turning the knob fully counterclockwise (to position “0”) cuts all input from microphone.

6. AUX Level Control
   This knob regulates the level of input from any equipment connected to the AUX jack on the rear panel, such as chimes, tape deck, rhythm box, etc. Rotate the knob clockwise to raise the level and counterclockwise to reduce it. Turning the knob fully counterclockwise (to position “0”) cuts all input from above equipment.

7. PHONO/TUNER Level Control
   This knob regulates the level of input from the tuner section of the unit, or connected record player. Rotate the knob clockwise to raise the level of input from the built-in tuner, and counterclockwise to reduce the level of input from the record player. At mid-position (“0”), input from either source is cut.
   This control operates on either tuner or record player, not both at once; signals cannot be mixed.

8. MASTER Volume Control
   This knob controls the overall level of the combined signals coming from MICS 1, 2, AUX, and PHONO/TUNER. Rotate the knob clockwise to raise the overall level of those signals together, and rotate it counterclockwise to reduce it. Turning the knob fully counterclockwise (to “0”) cuts all inputs.
   Note that this control should be used at position “5” or higher. If the master volume control is set lower than “5”, the separate controls for MIC, AUX, or PHONO/TUNER may cause “clipping” of input signals and increased distortion in sound.

9. Tuning Dial
   This knob tunes the desired AM or FM broadcast station. Use the lower half of the knob for AM band, and the upper half for FM band reception. Rotate the knob to bring the pointer on the knob to the desired position on the frequency scale around the knob.
(10) AFC Switch (FM)
This switch is used to prevent tuning drift originating in frequency deviation of local oscillator. As a general rule, set the switch to OFF when you tune in to a station, and to ON after tuning is complete.

(11) AM/FM Selector
This switch selects AM or FM reception. Note: Place the cover provided over the part containing tuning knob, AFC switch, and AM/FM selector when they are not in frequent use.

(12) Microphone Input Terminals
These are screw-type microphone input terminals. The 3 right-hand terminals are for MIC 1 connections, and the 3 left-hand terminals are for MIC 2 connections. Both MIC 1 and MIC 2 connections can be made simultaneously. The terminals have been already adjusted to accept low impedance (250 Ohms) balanced or unbalanced microphone. The stranded wire from the microphone should be hooked up to G terminal.

(13) PHONO Input Jack
This is a phonograph input terminal for RCA pin plug. When using stereo phonograph, use Y-adaptor for RCA plug connection.

(14) AUX Input Jack
This is an auxiliary input jack for RCA pin plug.

(15) TUNER Output Jack
This is a tuner output jack for RCA pin plug. It transmits signal from the built-in tuner independently, without mixing. To mute tuner, short-circuit the jack with shining plug.

(16) Music Muting Terminals
Short-circuiting GND and S terminals will immediately cut input signals at AUX and PHONO/TUNER (and signal from built-in tuner). Remove the short-circuit to regain state already established by front panel controls. This function is effective in interrupting music signals to insert announcement, etc. by means of microphones.

(17) Ferrite-bar Antenna
This is a built-in antenna for use in AM broadcast reception. Erect the bar towards you, and position it where the reception is optimal.

(18) Antenna Input Terminals
Use the terminals labeled 300Ω when parallel feeder is used, and the terminals labeled 75Ω for coaxial cable. The AM terminal is used to connect external antenna when sufficient electric field strength cannot be obtained with the built-in ferrite bar antenna.

(19) GND Terminal
This terminal is the connection for grounding wire of record player, etc. to reduce interequipment hum noise or induction noise, or to prevent static electricity.

(20) Speaker Terminals
Unit is provided with convenient speaker terminals for low impedance, high impedance, or constant voltage use. For low impedance use, 0, 6, and 16 ohm/25V terminals are available. For high impedance or constant voltage use, 70 volt terminal is available.

Terminals are quick screw-knob type. Loosen the knob, and the hole will open. Insert the bare end of speaker cable into the hole, and then tighten the knob so that the cable is securely fixed. (Refer to "CONSIDERATIONS FOR PA SPEAKER LAYOUT" for details on use of these speaker terminals.)

(21) Overload Protection Reset Button
This button resets the built-in protection device, which would cut the output when main amplifier section is overloaded because of mismatching of speaker impedance, etc. If the protection device is activated to prevent the unit from being damaged, remove the cause of overload, and press the Overload Protection Reset button to start normal operation.
*CONNECTING AMPLIFIERS IN SERIES*

If two PA music amplifier units are connected in series, the same speaker system can be driven with double power output.

Note: Do not use the G terminal (0V terminal) of the 4-pin connector on the Amplifier 2. Make connections for external equipment so that input signal is fed to the amplifier in parallel. Volume and tone controls on both amplifier units should be set at same level.

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**CONSIDERATIONS FOR PA SPEAKER LAYOUT**

**SPEAKER CONNECTIONS**

In connecting speakers to a public address amplifier it is important to present the amplifier with the load impedance it is designed to handle. Failure to do this can cause overheating and component failure. In many cases problems can take months to appear in the form of reduced reliability and unnecessary service calls. A load impedance rating is too low is especially bad. You should strive to have a load impedance of at least 70% of the chosen amplifier output impedance. For example, do not connect a 4 Ohm speaker to the 8 Ohm output. Driving a load of higher impedance than rated amplifier output is not as serious, but results in a power loss proportional to the mismatch and should be avoided. For example, driving a 16 Ohm load through the 8 Ohm output will result in a 50% loss in power. The high impedance mismatch should be kept to less than 200%, especially if it is anticipated that more than 50% of the rated amplifier power will be required.

There are two methods of connecting groups of speakers to the amplifier. Firstly, using the low impedance (i.e. 4, 8, 16 Ohm) outputs. This is preferable where:

(a) Runs are short (less than 200 ft. [70 m]).
(b) Few horns or speakers are to be used (i.e. typically 4-8)
(c) Some sound levels are required at each speaker.
(d) Low impedance also provides slightly better fidelity and frequency response.

High impedance or constant voltage is the second method and is preferable where:

(a) The runs are long and line losses are to be avoided.
(b) Many speakers are to be used.
(c) Different sound levels are required at different locations, for example indoor speakers and outdoor horns.
(d) Future expansion possibilities require flexibility in wiring layout.

The following is a more detailed discussion of these two methods.

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**LOW IMPEDANCE CONNECTION**

The speakers must be connected so as to present a combined impedance equal to the selected amplifier output impedance, i.e. 4, 8, 16 Ohms. The connections should be arranged in a series/parallel combination to achieve this according to the following formulae. The impedance should be between 70% and 200% of the output impedance selected. If the amplifier is to be driven anywhere near its full rated output the impedance should be well within these tolerances.

**Series — Connected Speakers**

\[
Z_T = Z_1 + Z_2 + Z_3 + \ldots + Z_N
\]

where \( Z_T \) = total combined load impedance
and \( Z_N \) = individual speaker impedance

\[Z_T = 1/Z_1 + 1/Z_2 + 1/Z_3 + \ldots + 1/Z_N\]

**Parallel — Connected Speakers**

\[Z_T = \frac{1}{Z_1 + Z_2 + Z_3 + \ldots + Z_N}\]

---

**SERIES/PARALLEL COMBINATIONS**

In larger systems it will be necessary to combine series and parallel connections to obtain the necessary impedance. The rules for calculating the total effective impedance is to divide the entire circuit into individual small series of parallel sub-circuits and apply the following rules to them.

The following is an example using 16 x 8 Ohm speakers. Each schematic is an impedance equivalent to its predecessor but has been simplified.

\[
Z(1-4) = Z_1 + Z_2 + Z_3 + \text{etc.}
\]

\[
Z(1-4) = 32 \text{ Ohms}
\]

\[
Z(5-8) = 32 \text{ Ohms}
\]

\[
Z(9-12) = 32 \text{ Ohms}
\]

\[
Z(13-16) = 32 \text{ Ohms}
\]

\[
\frac{1}{Z_T} = \frac{1}{Z(1-4)} + \frac{1}{Z(5-8)} + \frac{1}{Z(9-12)} + \frac{1}{Z(13-16)}
\]

\[
\frac{1}{Z_T} = \frac{1}{32} + \frac{1}{32} + \frac{1}{32} + \frac{1}{32}
\]

\[
Z_T = 8 \text{ Ohms}
\]

As can be seen, a problem arises if one more speaker must be added at some future date, as all the connections must be changed. This is not much of a problem if only a few speakers are involved, but if the network is extensive, the problem is significant. In addition, failure of one speaker can take out a number of associated units.

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**HIGH IMPEDANCE OR CONSTANT VOLTAGE (25V & 70V) SYSTEMS**

The high impedance or constant voltage method of impedance matching uses a high impedance amplifier output which is transformed down to 8 Ohms by an impedance matching transformer at each individual speaker. The big advantages of this approach as compared to low impedance are:
Reduced line losses and ability to use smaller wire gauges. This is due to the higher voltage and reduced current in the speaker lines.

(2) Much simpler impedance matching procedures and connections. Constant voltage is a misnomer in that the amplifier does not always produce 70V. Rather, the amplifier output impedance is set at such a level that, irrespective of its rated power, it will produce 70.7 volts output at full power. Thus a 10 Watt amplifier output load would have an impedance of 500 Ohms (V²/10 = 70.7/10), a 40 Watt amp would be 125 Ohms and 100 Watt amp, 60 Ohms:

Multiple transformer taps allow the impedance at each speaker to be adjusted individually to give a total matched load. Because of the high Impedance arrangement, the system is easier to impedance match and is also inherently less susceptible to problems caused by mismatching. The transformer taps are marked in Watts instead of Ohms (usually 4, 2, 1, ½). Again, it should be borne in mind that these levels of power output are only achieved when the transformer is working at 70.7 volts. The transformers are connected in parallel. A good match is obtained by ensuring that the total of all tap settings fits into the range of 40-80% of rated amplifier output. 80% is chosen to allow for transformer insertion loss. It is also good practice not to drive the amplifier to 100% of its capacity.

Examples are shown below. For simplicity it is assumed that all tap settings are the same at each speaker.

For a 40 Watt amplifier the range 40-60% is equivalent to 16-32 Watts. Therefore:

- 6 speakers x 4 Watt taps each = 24W
- 4 speakers x 1 Watt taps each = 4W
- 20 speakers x 1 Watt taps each = 20W
- 20 speakers x 4 Watt taps each = 80W
- 30 speakers x 1 Watt taps each = 30W

Note: None of the above tap settings guarantees the actual sound levels through each speaker. This is as much a function of the master volume control as the tap setting. The setting simply defines the maximum power consumed by an 8 Ohm speaker if presented with 70.7 volt input. In the case of a small number of speakers, it is always preferable to use a higher tap setting and reduced the sound level by turning down the master volume control. In calculating the amplifier rating needed for a typical music paging system using speakers distributed in an office environment, a good rule of thumb is to allow about 1W per speaker and space speakers at 1/2 X ceiling height. For noisy areas, or where the volume level required is higher, more power is required.

**PHASING**

When using multiple speakers in a sound system installation, it is advisable to phase the speakers in order to reduce the cancellation effect caused by improper phasing. Speakers out of phase will lose up to one-half of their normal volume and will operate with poor tonal characteristics.

For speakers facing in the same general direction, the speakers are in phase when all speaker cones move in the same direction when an equal signal is applied. With two speakers facing each other, proper phasing is achieved when the cone of one speaker moves inward while the cone of the other speaker moves outwards.

If speakers are unmarked, or not the same model, the following procedure will allow fast and simple phasing:

1. Connect one side of a flashlight battery to one of the speaker terminals.
2. Momentarily connect the other speaker terminal to the other side of the battery.
3. Note direction of cone movement (inward or outward).
4. Mark the speaker terminal that corresponds to the positive side of the battery.
5. Repeat the same procedure for each successive speaker, making sure that the direction of cone movement is the same for each case.
6. If the speaker cones are all to move in the same direction, connect the marked terminals to each other and the unmarked terminals to each other. If the cones are to move in opposite directions, as is the case when two speakers are facing each other, connect the marked terminal of each speaker to the unmarked terminal of each speaker.

**POWER LOSS IN LONG LINES**

For long lines the power loss in the lines (V²/R) becomes a significant factor. The power supplied by the amplifier is effectively reduced by the line loss. For a 0.5 db loss in sound pressure the total wire resistance must be limited to 8% of speaker impedance. The following table shows the calculated two wire cable lengths permissible for a number of wire sizes in feet. For a 1 db loss, the lengths may be doubled. For 2 db loss, multiply by 4.

<table>
<thead>
<tr>
<th>AWG Size</th>
<th>Resistance (Ohms/1000 Feet)</th>
<th>Low-Impedance</th>
<th>High-Impedance Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4Ω</td>
<td>8Ω</td>
<td>16Ω</td>
</tr>
<tr>
<td>14</td>
<td>2.50</td>
<td>48</td>
<td>90</td>
</tr>
<tr>
<td>16</td>
<td>4.02</td>
<td>30</td>
<td>90</td>
</tr>
<tr>
<td>18</td>
<td>6.39</td>
<td>19</td>
<td>76</td>
</tr>
<tr>
<td>20</td>
<td>10.14</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>22</td>
<td>16.72</td>
<td>7</td>
<td>28</td>
</tr>
</tbody>
</table>

**TECHNICAL SPECIFICATIONS**

**AMPLIFIER SECTION**

- Power Output: 40 watts
- Frequency Response: 50 Hz - 17.5 KHz, +1 dB, -3 dB
- Hum and Noise: MIC 1 Input = 55 dB below rated output, AUX Input = 70 dB below rated output, PHONO Input = 65 dB below rated output
- Sensitivity: MIC Input = 0.8 mV/250 ohms, AUX Input = 150 mV, PHONO Input = 3 mV
- Outputs: 4, 6, 10 ohms
- 25V (16 ohms), 70V (122.5 ohms)
- Inputs: 2 MIC (low-impedance), 1 MIC (high impedance), 1 AUX (high impedance, high level), 1 PHONO for magnet PHONO
- Controls: 2 MIC VOLUME, 1 AUX VOLUME, 1 TUNER/PHONO VOLUME, MASTER VOLUME, BASS and TREBLE
- Tone Control Action: BASS = -6 dB, -12 dB (100 Hz)
- TREBLE = +7.5 dB, -12 dB (10 kHz)
- Muting Level: -30 dB
- TUNER SECTION (at TUNER OUTPUT)
  - Frequency Range: AM: 535 - 1605 kHz
  - FM: 85 - 108 MHz
  - Sensitivity: AM: 500 µV for 20 dB quieting
  - FM: 4 µV for 30 dB quieting
  - Distortion: AM: 1.5%, MOD 30% 400 Hz
  - FM: 0.8%, MOD 100% 400 Hz
  - Hum and Noise: AM: 40 dB
  - Output: AM: 220 mV, MOD 30% 400 Hz
  - (at TUNER OUT): FM: 600 mV, MOD 100% 400 Hz

**MISCELLANEOUS**

- Power Requirement: 120V AC/60 Hz
- Power Consumption: 105 watts
- Dimensions: 170 (W) x 34 (H) x 210 (D) mm
- Weight: 4.9 kg/10.8 lbs.

* Specifications and features subject to possible modification without notice.*