Outdoor Volume Control
Model 50-7885

Installation Instructions

INTRODUCTION

The MCM **Impedance Matching Outdoor Volume Control** is designed for connection between the speaker output of an amplifier, speaker selector, or distribution box, and a speaker pair. It adjusts the volume of remote speakers by attenuating the audio signal, after the amplifier. To assure maximum power transfer and efficiency, and minimal heat, this control uses autoformers instead of L-pads or resistor networks.

SPEAKER and AMPLIFIER IMPEDANCE

Calculating Speaker Impedance

All speaker systems place a load on the amplifier driving them. That load, determined by the impedance of each speaker system, is measured in ohms (designated by the Ω symbol). The actual impedance of a given speaker system will vary depending upon the frequency at which that impedance is measured. To ease impedance calculations, speaker manufacturers rate speakers at average (or nominal) impedance, across the rated frequency response of that speaker. For consistency, most in-wall and ceiling speaker manufacturers follow an established standard of **8Ω**. This ensures that multiple–speaker installations have power distributed evenly across the entire system. From this point forward, all calculations will be with regards to one amplifier channel. In stereo applications, the same consideration must be given to both the left and right channels.

When multiple speakers are connected in parallel, the overall impedance **DECREASES**, thus **INCREASING** the load on the amplifier. For example, when two **8Ω** speakers are connected in parallel (that is with the (+) terminals connected together, and the (-) terminals connected together, the resulting impedance is **4Ω**. If four **8Ω** speakers are connected in parallel, the resulting impedance is **2Ω**. To calculate this, you use the following formula

$$1/R_1 + 1/R_2 + 1/R_3 + 1/R_4 = 1/R_T$$

Where R_1 is the impedance of the first speaker, R_2 is the impedance of the second etc., and R_T is the total impedance.

If the above speakers are all **8Ω**, then each R on the left side of the equation will be replaced with the value of 8. The resulting formula would read as follows:

$$1/8\Omega + 1/8\Omega + 1/8\Omega + 1/8\Omega = 1/R_T$$

Which simplifies to:

$$4/8\Omega = 1/R_T$$

or

$$1/2\Omega = 1/R_T$$

or

$$R_T = \underline{2\Omega}$$

Therefore, when four **8Ω** speakers are connected in parallel, the resulting impedance is 2Ω.

The Simpler Method

Since all speakers in a given system are typically be the same impedance, a much simpler formula may be used.
Note: this may only be used if all speakers are rated at the same impedance.

$$R/N = R_T$$

Where R is the impedance of the speakers, and N is the number of speakers connected in parallel. In this case the same situation as above may be stated in the following manner:

$$8\Omega/4 = R_T$$

or

$$\underline{2\Omega} = R_T$$

AMPLIFIER LOADING

Adding additional speakers to an amplifier increases the load on that amplifier.

Example:

Take a single pair of **8Ω** speakers, connected to a stereo amplifier, with the amplifier volume control set to provide 5 watts RMS output. If a second set is added, and the volume setting is unchanged, the output of the amplifier will increase to 10 Watts, thus providing 5 Watts to each pair (assuming this is within the limits of the amplifiers capability).

Virtually all solid-state amplifiers are designed to accept **4Ω** speaker load. Therefore two sets of speakers are typically not a problem. Additionally, many of today's higher current residential audio amplifiers are designed to accept **2Ω** speaker loads. In this case, up to four sets of **8Ω** speakers may be connected without concern. If this number of speakers is exceeded, the load on the amplifier will be too high, and the amplifier will go into protection mode (temporarily shut down or cut out to protect itself), and even possibly sustain damage.

IMPEDANCE MATCHING VOLUME CONTROLS

Based on the information above, normally no more than two pairs of **8Ω** speakers can be connected to a **4Ω** stable stereo amplifier, and no more than four pairs of speakers may be connected to a **2Ω** stable amplifier, without some type of impedance matching device.
Note: If the minimum speaker impedance load of an amplifier is not known, then assume it is **4Ω.**

This Impedance Matching Volume Control includes selectable jumpers to provide impedance multiplication to the speaker system. The available jumper positions are **x1, x2, x4, x8 and x16.** These positions represent the value that will be multiplied with the speaker impedance, to provide a higher number. For example, an **8Ω** speaker, connected to an Impedance Matching Volume Control, set at the **4x** position, will have a resulting impedance of **32Ω.** In the same situation, if the control is set to the **8x** position, the resulting impedance will be **64Ω.**

From the simplified formula earlier, you will see that with a volume control, set to the **8x** position, a total of (16) **8Ω** speakers can be connected in parallel, and will appear as a **4Ω** load**.** Therefore, by using impedance matching volume controls, you can connect up to 16 pairs of **8Ω** speakers to a **4Ω** stable amplifier.

When calculating the total impedance of a network of speakers, often times the final value is not exactly **4Ω** or **8Ω.** For example, take 5 sets of **8Ω** speakers, to be connected to **4Ω** stable amplifier. Using Impedance Matching Controls set to **2x,** each speaker system would then be **16Ω**.
Using the formula:

$$1/R_1 + 1/R_2 + 1/R_3 + 1/R_4 + 1/R_5 = 1/R_T$$

Inserting **16Ω** for each value of **R:**

$$1/16\Omega + 1/16\Omega + 1/16\Omega + 1/16\Omega + 1/16\Omega = 1/R_T$$

Which simplifies to:

$$5/16\Omega = 1/R_T$$

or

$$16/5\Omega = R_T$$

$$R_T = 16/5\Omega \text{ or } \underline{3.2\Omega}$$

In this case, the total impedance of five sets of **8Ω** speakers, with Impedance Matching Volume Controls set to **2x**, yields a total impedance of **3.2Ω**. If this is a **4Ω** stable amplifier, this value is too low, and will cause the amplifier shut down, and possibly sustain damage. Therefore, in this situation, it will be necessary to set the Impedance Matching Volume Controls to the **4x** position. Using the same formula, you will see that the resulting impedance is now **6.4Ω,** which is within the acceptable level.

Note: In the above case, if the 8x position were selected, the resulting impedance would be **12.8Ω.** This is completely acceptable with solid state amplifiers, as they will function reliably with loads well above **8Ω.** And in situations where a quantity of speakers is installed, with future plans for expansion, this may even be desirable. However it should be noted, that at these higher impedances, the amplifier load decreases, thus reducing the overall output capability of the amplifier. For example, if an amplifier is able to deliver a maximum of 100 Watts at an **8Ω** load, the maximum output with a **16Ω** load will be only 50 Watts.

INSTALLING THE OUTDOOR VOLUME CONTROL

Mounting

The included fully weatherproof box can be mounted flush to any wall surface using the attached four mounting tabs. Additionally, it can be fully supported by 3/4" PVC conduit, if that conduit is sufficiently anchored.

Connections

When routing cable through walls to speakers and volume controls, care should be taken to avoid close proximity to AC power lines. This is important for safety reasons, as well as reducing the possibility of noise being introduced on the line. When selecting in–wall speaker wire, be sure to use cable designed for that purpose. Two or four conductor, 16AWG or 14AWG wire is recommended, and most local electrical codes require cable to carry a CL2 or CL3 rating. Be sure to verify compliance with local codes prior to installation.

Caution: Speaker cabling and AC power lines should never pass through the same opening drilled in interior wall studs.

Connections on the control are clearly marked as follows

Output	**Input**
Left + ; Left – ; Right – ; Right +	Left + ; Left – ; Right – ; Right +

Each connection will accept up to 14AWG wire. Strip 1/8" of insulation from the end of each speaker lead to be connected to terminal. To make connection easier, the terminal strip may be unplugged from the volume control, allowing easy attachment of all four conductors. Once all connections are made, the terminal strip may then be simply plugged back into the control.

Use extreme care to be certain that polarity and input/output connections are properly made. Incorrect wiring of this control can result in damage to the amplifier or connected speaker selectors.

Once the speaker connections are made, set the Impedance Matching Jumper to the desired position. Be sure to set both the left and right jumper.

FINAL SETUP AND USE

Testing

Once all controls and speakers are installed, it is recommended that the system be tested prior to connection to the amplifier. This will ensure that the desired speaker load is present at the amplifier output, thus preventing possible amplifier shutdown or damage. The most effective way to accomplish this is to measure the impedance at the amplifier (without the amp connected).

An impedance measuring device is required to accurately accomplish this. A cost effective example of this device is the Tenma Audio Impedance Meter, model #72-6947. This meter measure the impedance of a speaker system, at an audio frequency of 1KHz. This step can serve as a reliable method of preventing unreliable and potentially damaging operation later.

Note: Using a standard DMM, ohmmeter or multimeter is not effective for this purpose, as these devices measure impedance at DC, not at an audio frequency. Since a speakers and volume control devices impedance varies with frequency, a standard ohm meter will not provide accurate readings.

Setup

- Once the amplifier is connected to the system, prior to turning on the power, make sure that the amplifier gain (volume) is set to the **MINIMUM** setting
- Be certain that all In–Wall and outdoor volume controls are set to the **MAXIMUM** setting
- Turn the amplifier on and select a desired music source
- Slowly increase the volume of the amplifier until sound is heard from the speakers
- Walk through all areas in which speakers are installed, and make certain that sound is present at all speakers
    - If sound is not present at any speaker, turn off the amplifier power and check speaker connections
- Adjust the volume or balance control fully to one channel (either left or right)
- Again, walk through all areas, noting that sound is present at only one speaker
- Change the volume or balance control to shift fully to the opposite channel (either left or right)
- Walk through all areas, noting that sound is present at the opposite speaker than in the prior walkthrough
    - If incorrect results occur, turn off the amplifier power and check speaker connections
- Adjust the volume or balance control so that the left and right channels are now equal
- Now adjust the volume of the amplifier to just above the level that will be considered the maximum listening level from the system
- Move through each area, adjusting the in–wall volume controls to a comfortable listening level

Note:
If at any time, the amplifier temporarily disengages, or shuts down, the system should be powered down and checked for proper connections. If it is determined that all speakers, volume controls or other devices are connected properly, and the system continues to shut down, there is possibly a speaker impedance problem.

In this case, power down the system, remove the volume controls from the wall, and select the next higher impedance multiplier setting. For additional information regarding distributed audio system installation, please consult documentation included with other components. For additional questions, please contact the MCM Technical Support Department at 1-800-824-8324, or send an email to tech@mcminone.com.

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