Objectives

Study commercially available Class D amplifiers with a focus of audio quality and noise.

2 Study and comparison of commercially available conventional Class AB/B amplifiers with similar specifications and constraints.

3 Build a Class D amplifier using readily available circuits/subsystems.

4 Continue research on an observation of voltage requirements in Class D amplifiers.

Examine McDonald's current audio environment and apply the obtained knowledge to help provide a global business solution to their drive through ordering systems.

Team

Faculty Advisor: Dr. Thomas Wong Graduate Advisor: Tao Shen Team Leader: G. Wakhlu

Research Team G. Choi, M. Mikulka, C. Song, G. Wakhlu

This field involves researching commercially available class D amplifiers. It is compared with class A, B, and AB amplifiers. Team members may be required to regularly report findings to the entire IPRO.

Webpage Team D. Spears, J. Godfrey, Y. Park, C. Sun

The Webpage team is charged with the responsibility of designing, deploying, and maintaining a public webpage displaying information relevant to IPRO 344 and the field of Low-Power Audio devices.

Documentation Team N. Kwak, Y. Zhang, N. Terry, D. Spears

The Documentation team is responsible for creating, maintaining, and posing all IPRO and IPRO related documents through official channels, including the team Wiki.

Purchasing Team N. Terry, M. Mikulka

The Purchasing team is responsible for reviewing, proposing, and acting on all team purchase requests, as well as maintaining documentation on all purchases and any necessary budget reports.

Implementation Team J. Godfrey, H. Cho, G Wakhlu, G. Choi, N. Kwak, C. Song, M. Mikulka

The Implementation team is responsible for assembly, operation, and maintenance all equipment studied as part of this IPRO, including Evaluation boards, commercially purchased amplifiers, amplifier components, audio sources and loudspeakers.

Tools and Media Team Y. Zhang, D. Spears, C. Sun The Tools and Media Team is responsible for the assembly, operation, and maintenance of instrumentation used

throughout the IPRO as well as the preparation of acquired data for presentation.

Poster Team Y. Park, Y. Zhang, G. Wakhlu, H. Cho The Poster team is responsible for creating a professional summary-poster to be used during team presentations

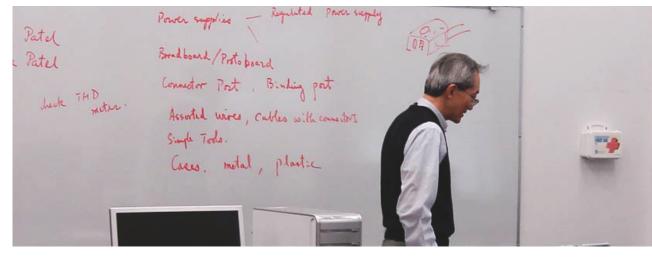
and during IPRO day.

Logistics & Attributes Team G. Wakhlu, N. Terry

Presentation Team G. Wakhlu, N. Terry, C. Song



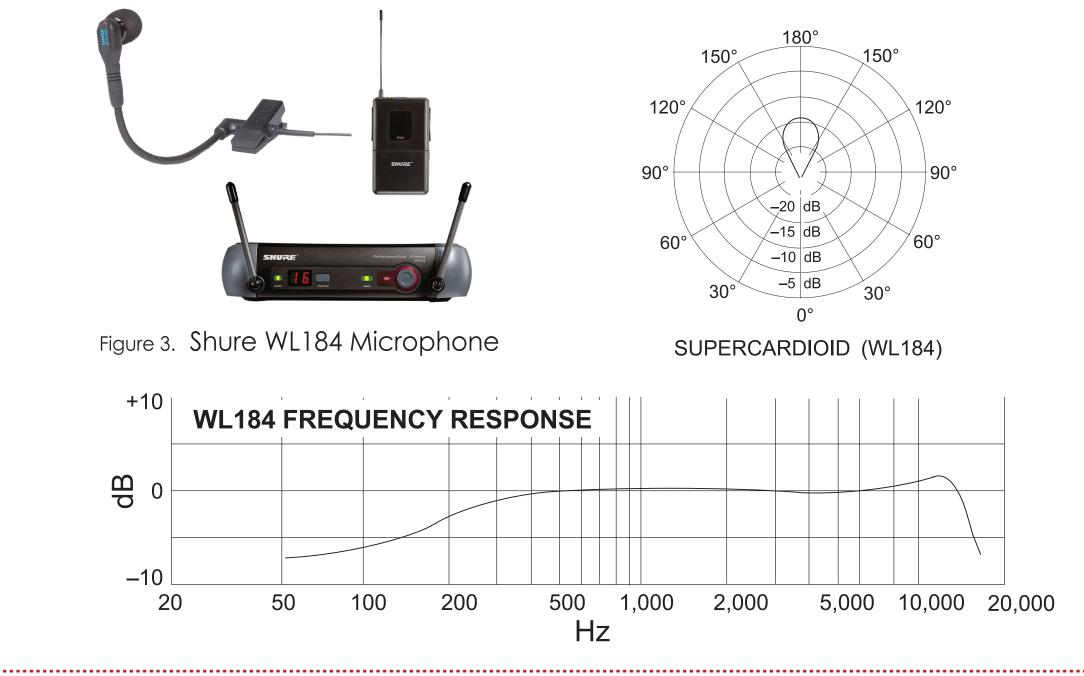


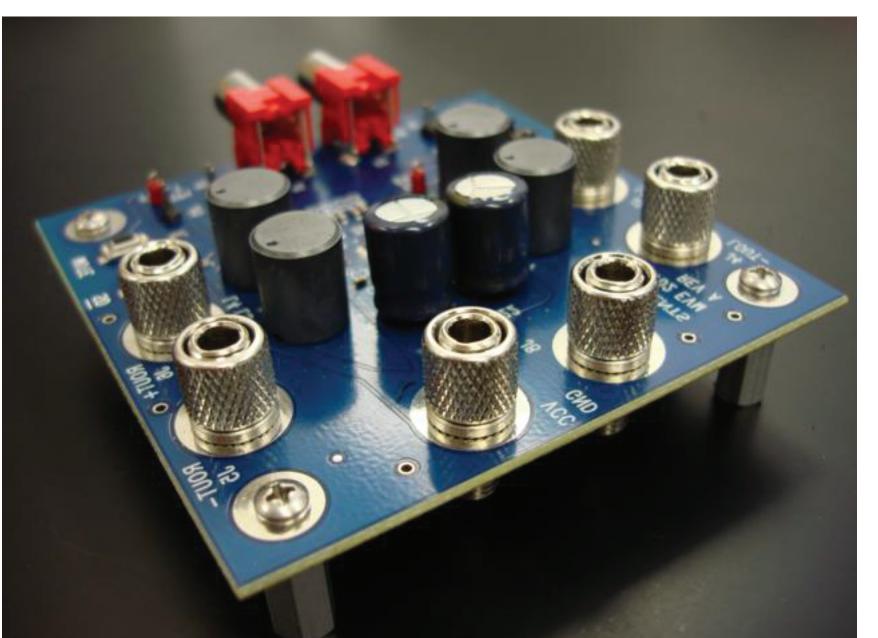


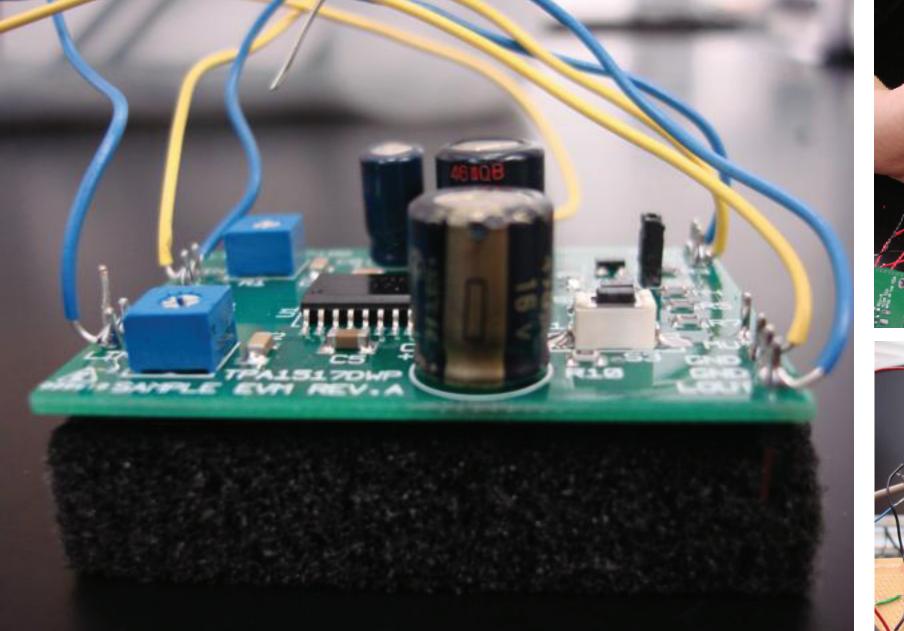
The Microphone:

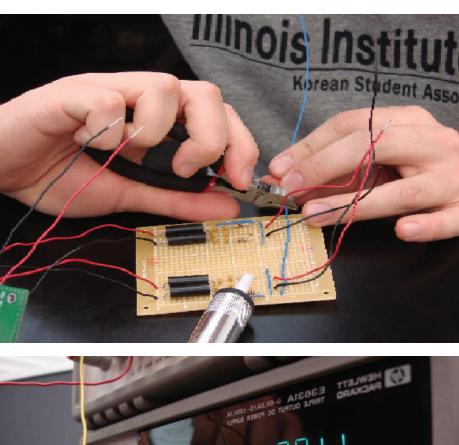
It is common knowledge that the microphone converts mechanical energy (vibrations) into electrical impulses that can be used for amplification and signal processing. The issues we encountered during our microphone research were: Pickup angle (is it omni-directional or uni-directional), Frequency Response (since microphones might cutoff sounds at certain frequencies), Sound quality and the need for a windscreen.

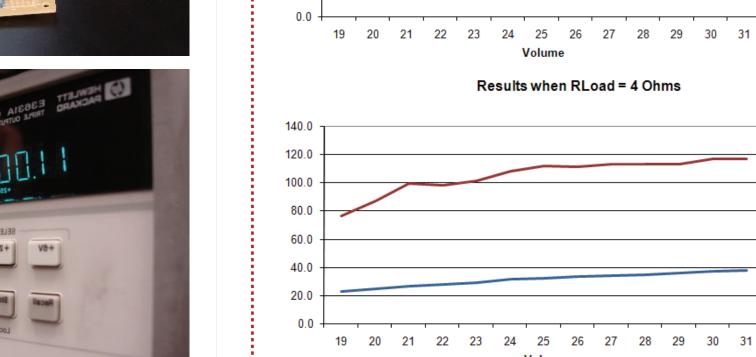
After much research and a visit to Shure Inc.'s worldwide headquaters in Niles, IL, we decided that the WL-184 omni-directional microphone would be suitable for our needs due to its frequency response, sound quality and the fact that it is able to pick up sounds from a greater angle without picking up much noise.









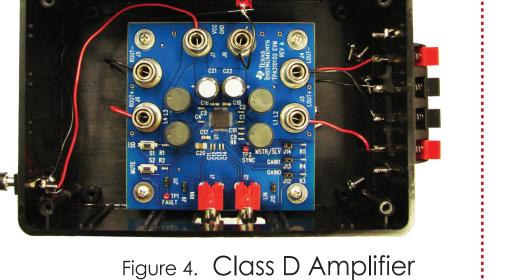


The Class D Amplifier

Class D amps are sometimes called digital amplifiers. There is really no such thing today as a digital amplifier. A Class D amplifier uses transistors that are either switched on or off to represent positive or negative values. The transistors are either on or off. The advantage of such a system is that it is highly efficient and generates very little heat. The disadvantage is that there can be

a distortion caused between the switching of the positive and negative transistors as the positive and negative transistors can not be on at the same time.

Many Class D amplifiers are finding their way into Subwoofers. They are inexpensive to build and the logic is that the switching distortion is not important in a subwoofer.



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Class D Amplifiers and Their Benefits

The Amplifiers are classified into letter grades based on how the original waveform is amplified.

Class A/B amplifiers are very common.

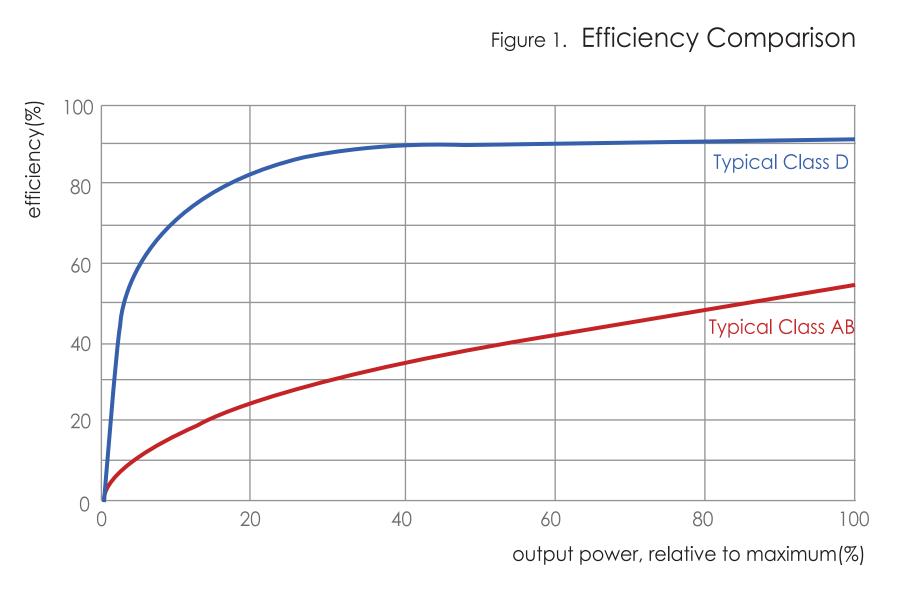
Microphone

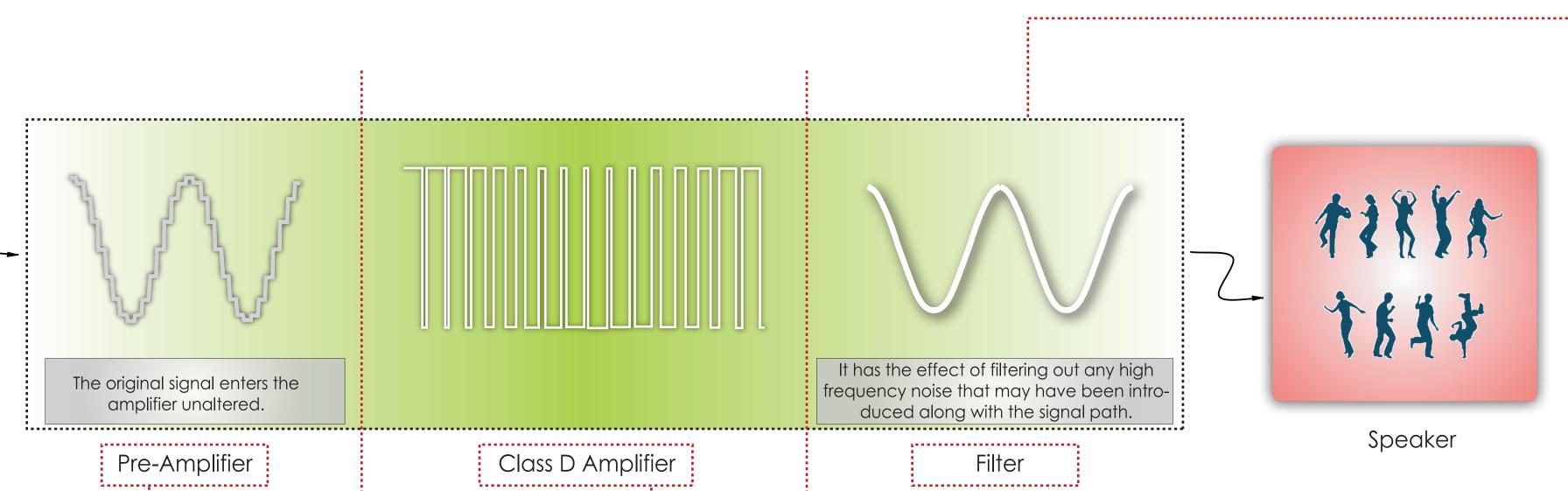
Results when RLoad = 8 Ohms

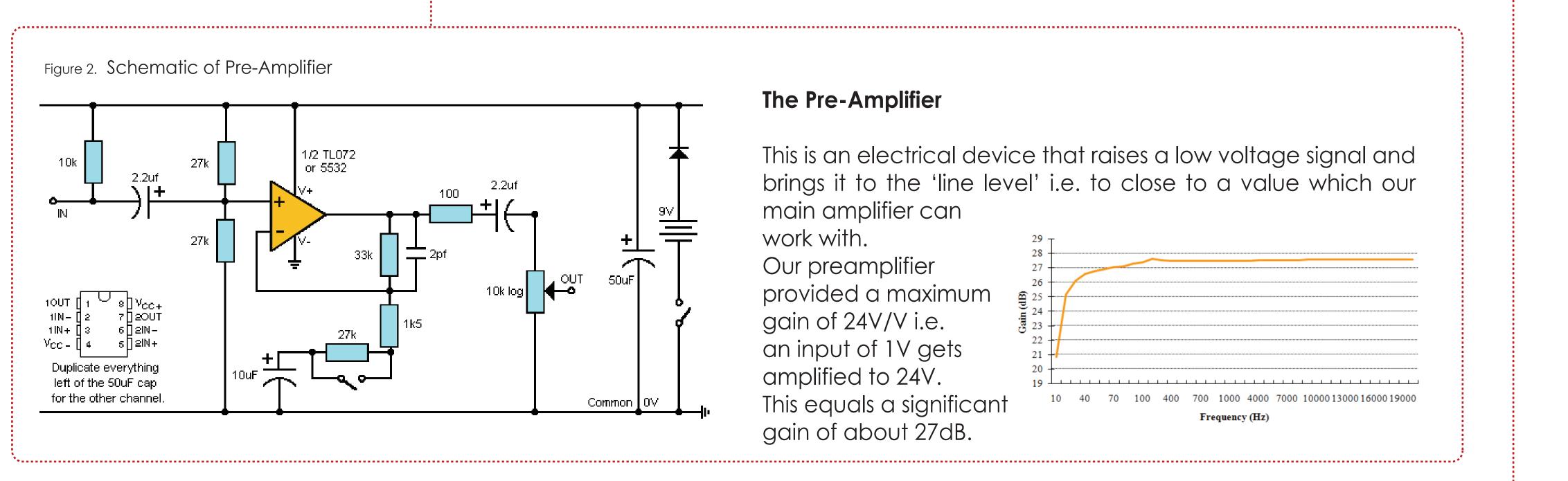
Results when RLoad = 4 Ohms

Class D is a better option to increase the maximum efficiency of these amplifiers. Indeed, compared to traditional amplifiers that have output devices that conduct even when "off", which leads to power dissipation and zero percent efficiency during this time,

Class D amplifiers operate with the maximum theoretical efficiency (≥ 90%) – as shown in Figure 1- of any audio amplifier, with minimum audio distortion because power dissipation is theoretically zero in the "off" state. It draws less current from the power supply, thus requires smaller heat sink and leads to a reduction and compact circuitry.







The McDonalds Project

McDonalds needs improvement in their driving-thru system. Our team could contribute the technology on audio system improvement. McDonald's concerns with its drive through system may stem from a number of sources. To begin with the equipment may be dated and has not been upgraded for some time. From a customer's perspective, the issues that need to be addressed are:

1. Order Accuracy: It reduces the efficiency of a busy Drive Through by 40% if an order needs to be retaken. Hence, clarity on both ends of the system is necessary. Some factors are important to ensure this:

- Sound Quality / Noise Reduction
- Sound Amplification
- Speaker and Microphone

2. Drive-Thru Experience: According to surveys, one bad experience at a drive-thru can bring negative influence to the customer's purchase at McDonalds thus resulting in reduction in profits. The requirements range from a well organized menu, to the order taker's pleasantness and verification of the order correctly, readiness of the order and so on. In out project, over this semester and the next couple we will try to focus on:

• Efficient Speech Recognition: Either improve the current McDonald's system by changing amplifiers, preamplifiers, microphone positioning and the choice of microphone on both ends of the drive-through so that the order taker can recognize various accents with more clarity and the customer can understand the ordertaker.

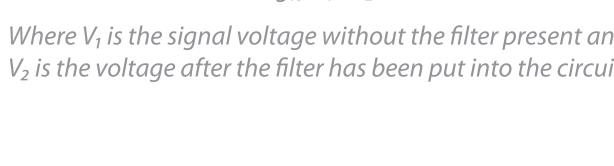
• Order Record and Processing: Our team might look into the possibility of the order being recorded and processed quicker using speech recognition.

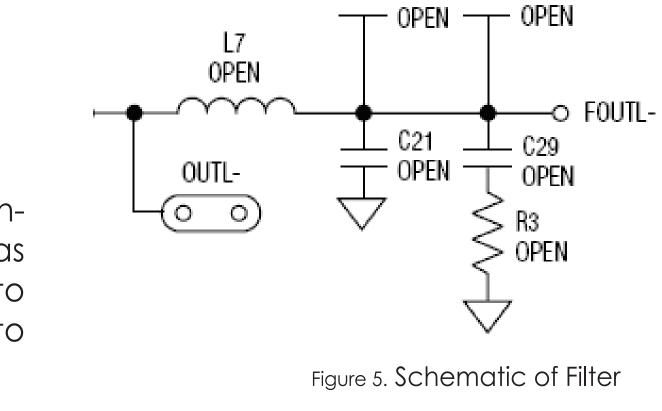


Typical Filter Performance

The performance of low pass filter is often characterized in terms of an insertion loss curve. Insertion loss can be described as the ratio of voltage across the load with and without the filter.

Insertion Loss (dB) = $20 \log_{10}(V_1/V_2)$ Where V_1 is the signal voltage without the filter present and V_2 is the voltage after the filter has been put into the circuit.





The Filter

EMI filters and RFI filters describe unwanted signals (noise) that EMI filters and RFI filters are intended to eliminate. For this application, filtering was achieved by discrete devices such as capacitors, resistors and inductors. EMI filters have three main functions, the first is of course to filter EMI/RFI, the second is to protect inputs and outputs against ESD and the third one is to transmit data from inputs to outputs.



