Newcomers' Notebook

Making Sense of Circuits

Simple explanation without complex mathematics

by Jules Perrin VK3JFP

Making sense of a circuit diagram, for the first time, may seem to be a daunting task. This article will break down the process of reading a simple circuit diagram into logical steps. After this article, my hope is that you will not feel so intimidated by complex drawings and explore the circuits.

Over the past issues, I addressed Ohm's Law, resonant circuits, diodes, transistors and operational amplifiers. I have tied these articles into a simple Amplitude Modulation (AM) receiver. This project is not intended to be constructed as I pieced this together for this exercise. There are many excellent circuits for AM receivers on the internet.

This simple circuit diagram in Figure 1* draws together the topics we addressed, and I am using this to explain how to read the circuit diagram. I did make the circuit and it did work but not well. A simple crystal radio set is a better place to start if you are interested in AM radio.

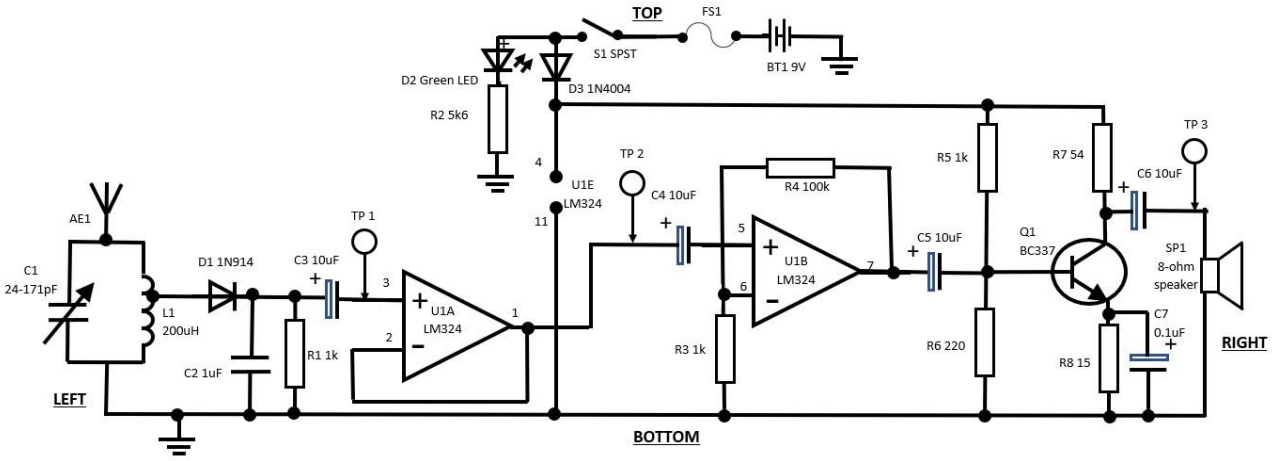

Figure 1: AM Receiver Circuit.

Circuit Layout

The general convention for circuit drawings is that there are five focal points in any circuit you wish to read. These five focal points in each circuit drawing. (Left and Right. Top and Bottom. Centre) Each focal point has a specific role to play. I am sure there are variations to this convention, but this is a good place to start.

I have included these focal points on the drawing to allow you to orient the drawing the correct way. These markings would not be on an actual circuit.

Left

Thel Left side is where any signal enters the circuit. In Figure 1, the signal entering the circuit comes from the antenna AE1. Other circuits may have the input coming from a previous stage or circuit.

The left side is generally where you start so you can understand what is coming into the circuit.

Right

The Right side is where any signals, processed by the circuit, exit the circuit. In Figure 1, the signal exits via the speaker SP1. In multi-page circuits, this is where the signal would exit and the next destination for the signal would be indicated.

Top

The top is where the DC supply for the circuit will be identified.

Bottom

The bottom is where the earth for the circuit is drawn.

Centre

The centre, between the left and the right sides, is where the signal is processed and performs the function it was designed to do. Reading the name of the circuit will usually give a good starting point in understanding the circuit.

Circuit At a Glance

The signal flow goes left to right and is processed in the circuit. Electron flow, for the circuit's power, goes from bottom to top. I find it better to use electron flow rather than conventional flow for applications with active components.

Application to Figure 1

Looking at Figure 1, the signal input originates in the antenna at the frequency selected by the combination of C1 and L1. This circuit you would recognise as a parallel tuned circuit. If the selected frequency is the same frequency for an AM station, the output will be an amplitude modulated carrier wave as shown in Figure 2 A.

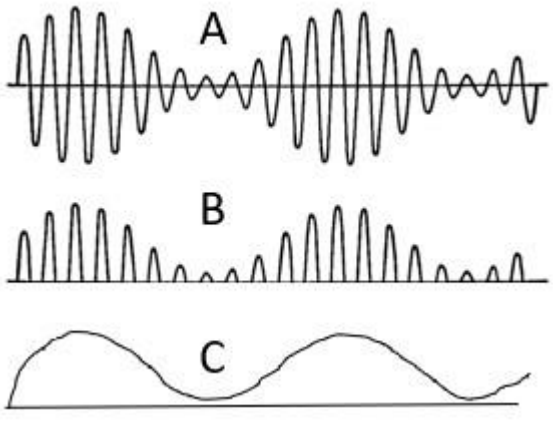

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Figure 2: AM signal.

The next step in processing the AM signal is to send it through a detector stage. Detectors for AM and discriminators for FM. The first component the signal passes through is a diode D1. The diode only allows electrons to flow one way so, the output will be one side of the signal as shown in Figure 2 B. After rectification, the signal is smoothed by R1 and C2 as shown in Figure 2 C. The result is a signal in the audible range but extremely low in strength.

C3 is a polorised coupling capacitor linking signal stages. This allows signals to pass and blocks any DC.

TP1 is the first test point. Small circuits would not normally have test points shown but I have added three to introduce the concept. A test point can have a small drawing next to it or a reference for you to look up in another document. However it is indicated, the diagram usually shows what size and shape signal that can be detected at that point. This is a great tool in fault finding circuits.

U1 is a 14-pin dual inline package (DIP) chip with four operational amplifiers. In this circuit, only two of the four are used (U1A and U1B). U1A is configured as a buffer amplifier. The input and output are the same but the input to U1A does not impose any drain on the previous stage.

TP2 is another defined test point.

C4 is a polorised coupling capacitor linking signal stages.

U1B is an operational amplifier configured to amplify the signal approximately one hundred times. The amplification ratio is determined by R3 and R4. To put this amplification number in perspective, if the input signal is 0.01V amplified by one hundred equals 1V.

C5 is a polorised coupling capacitor linking signal stages.

Q1 is configured as a class A amplifier with R5 and R6 providing the bias on the base. Q1 drives the speaker (SP1) through a coupling capacitor C6.

TP3 is another defined test point.

C7 is a bypass capacitor for any RF signals.

Power Supply

Going back to the top of the circuit, the source of DC supply for the active components in the circuit is a 9V battery (BT1).

FS1 is a fuse that protects the circuit if excessive is current drawn from the battery.

When the switch (S1) is closed, electrons will flow from the ground through the circuit to the positive side of the battery. D3 is a diode designed to prevent current flow if the battery is inserted incorrectly.

R2 and D2 is an indication circuit that will glow green when S1 is closed.

U1E are the power and earth pins on the operational amplifier DIP.

Well done

Congratulate yourself! You just read your first circuit. By breaking any circuit down to simple stages, and individual components, you begin to understand how the circuit works.

** I apologise to all the drawing, engineering and AM radio purists up front. I am sure you will find glaring holes in my drawing, but the principal issue is that this drawing is designed as an introduction to circuit reading for newcomers, to both the hobby and electronics.*

If you have a topic you would like to nominate to be covered in a future instalment of Newcomers' Notebook, email Jules at jp.bqt@bigpond.net.au

Have fun and stay safe.