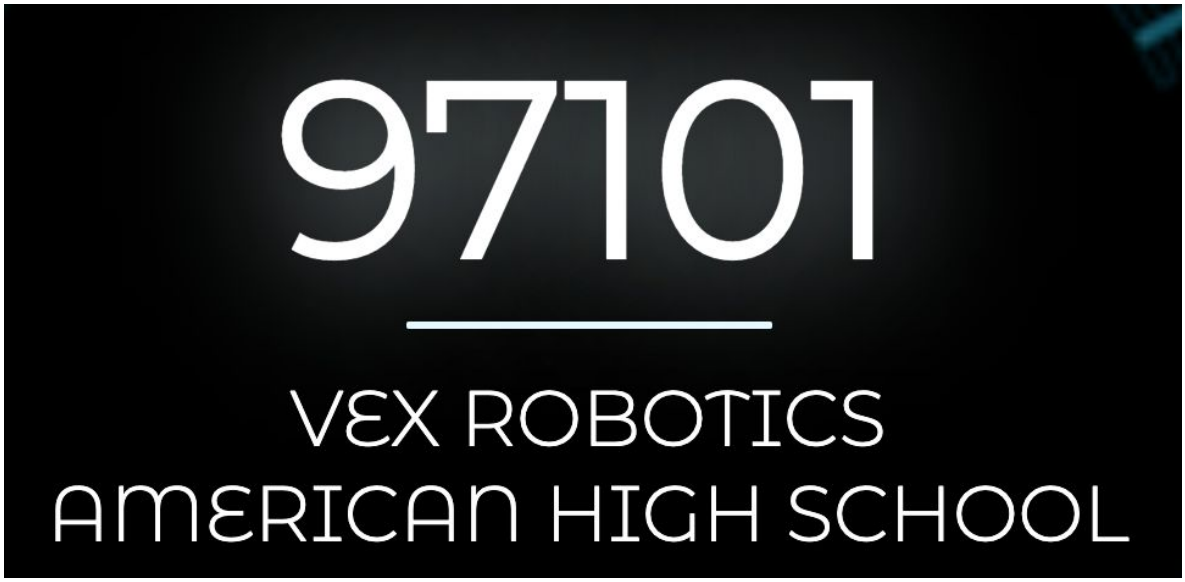
Texas Instruments Electronics Online Challenge 2020-21

Disassembly and Analyzation of a Multimeter



Team Name: Thing Two
Team Number: 97101W
School: American High School

Challenge Lead:
Sheza Saiyed

Contributors:
Asilah Maryam
Grace Zhen
Ashita Singh

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Final Report

Electricians, engineers, and designers, all find the multimeter a tool of great use. Digital multimeters combine the tasks performed by single instruments such as voltmeters, ammeters, and ohmmeters, therefore, proving to be an extremely efficient tool for engineers. We often used it during robotics and in our engineering class, and its functionality intrigued us. Hence, we chose to further investigate its interiors to gain a broader understanding of the circuitry.

We found and researched three main components of the circuit of the device: the fuse, the crystal oscillator, and the metal oxide varistors. There were no TI components identified within the device.

One of the components inside the circuit of a multimeter is the fuse. The fuse plays a significant role as it prevents damage to the circuit from a current overload. A common error that occurs while using a multimeter is adjusting the device to measure resistance or current but instead measuring voltage. This can cause the circuit to blow if no fuse is incorporated. However, a fuse will take the overload, protecting the rest of the circuit from being damaged. The fuse incorporated in our multimeter was 400mA, however, some of the better quality multimeters consist of high rupture capacity (HRC) ceramic fuses which have a capacity of over 20kA.

The second component we researched was the crystal oscillator. It is an electronic oscillator circuit that utilizes the mechanical resonance of a vibrating crystal to create an electronic signal with a constant frequency. They can offer low impedance when connected in a series and high impedance when connected in a parallel. In a multimeter, the crystal oscillator works on the principle of the inverse piezoelectric effect. The field will mechanically deform some materials which after which the oscillator will use the resonance produced by the crystal's vibration to generate electrical signals of specific frequencies.

The last components we researched were the Metal Oxide Varistors (MOV). A varistor is a Variable Resistor. It is also known as Voltage Dependent Resistors. An MOV is a protection component, similar to a fuse. They are similar to resistors, however, their leads do not have polarity. In a multimeter, there are typically three MOVs: all in the same general area. They protect the circuit from high voltage spikes. For instance, when a multimeter measures a component and the voltage is extremely high, then that voltage passes through the MOVs, and the resistance of the MOVs decreases. This lowers the transient voltage to a safer level. This is crucial in order to prevent the circuit from being damaged due to high voltage spikes.

The disassembly of this multimeter not only gave us insight into the specifics of the circuit of just the multimeter, but also gave us knowledge about electricity and circuitry in general. We always used this device in our engineering class and while doing robotics so this investigation fed our curiosity about its functionality. The research gave us a broader understanding of electronics and its significance in everyday products.

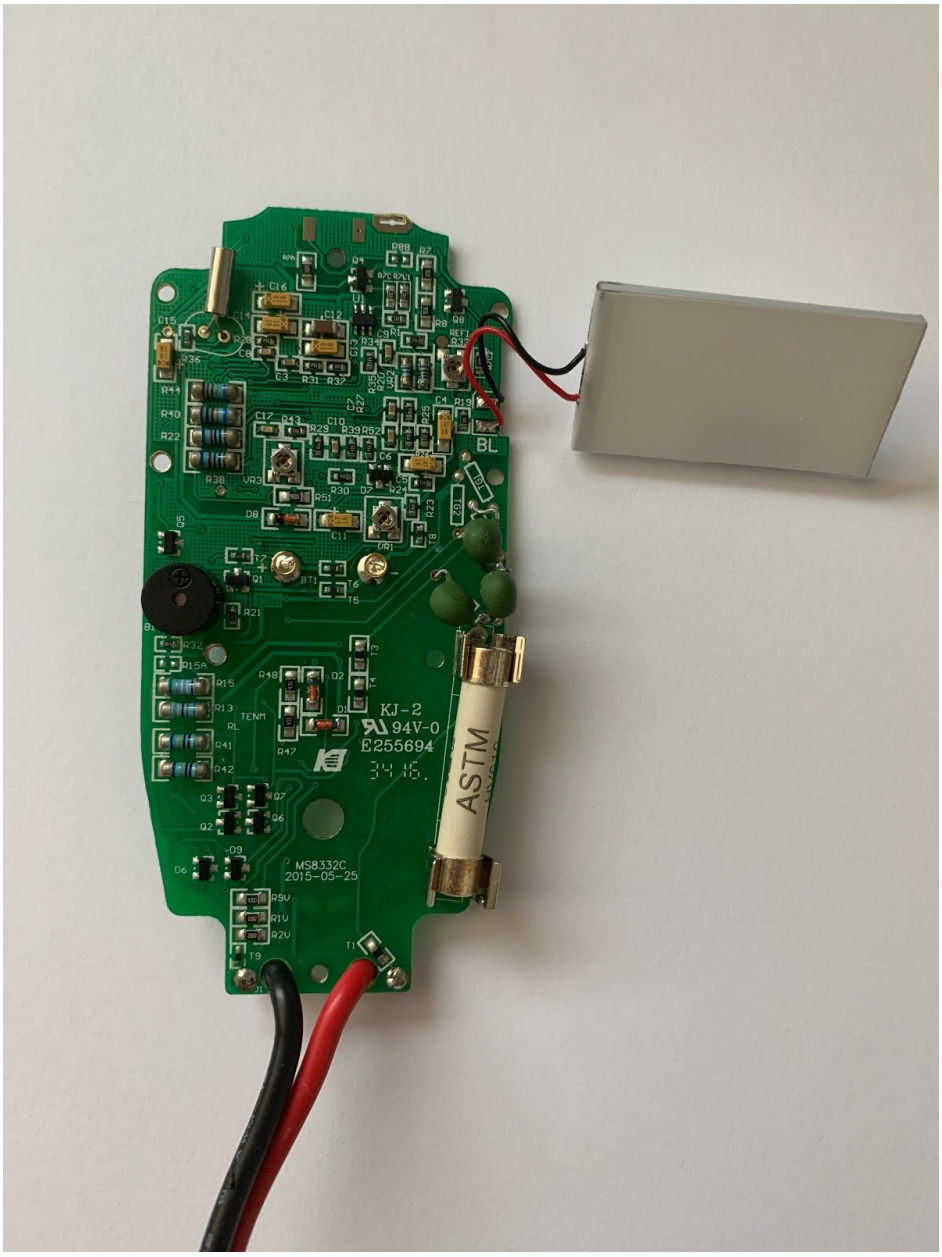
Device Image (Intact)

MS8332C Digital Multimeter

Device Image (All Parts)

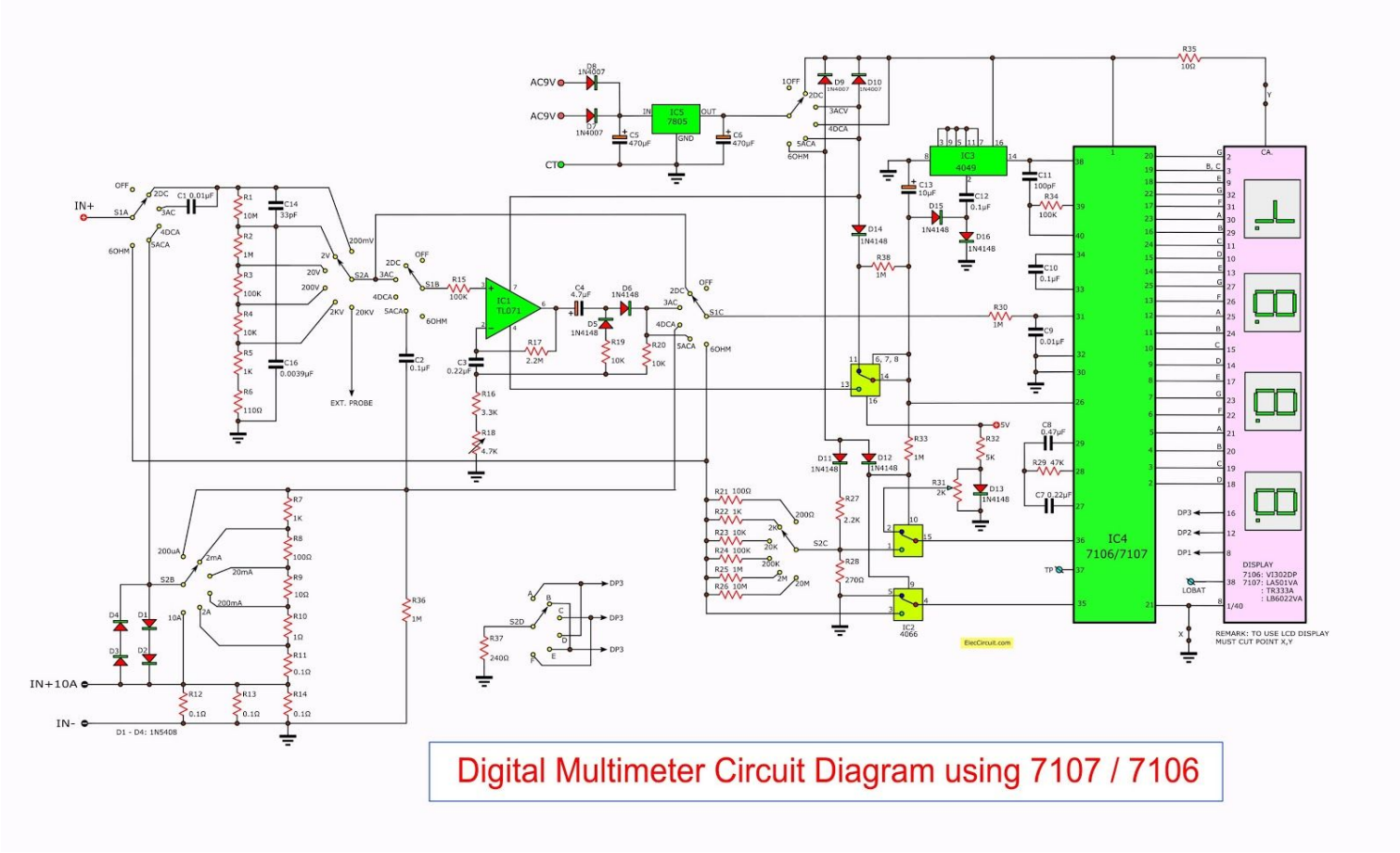
Bottom left: front piece with switch;
Top Left: Back Cover; Top Right: LED Display and cover; Bottom Right: Circuit

Device Image (Circuit)

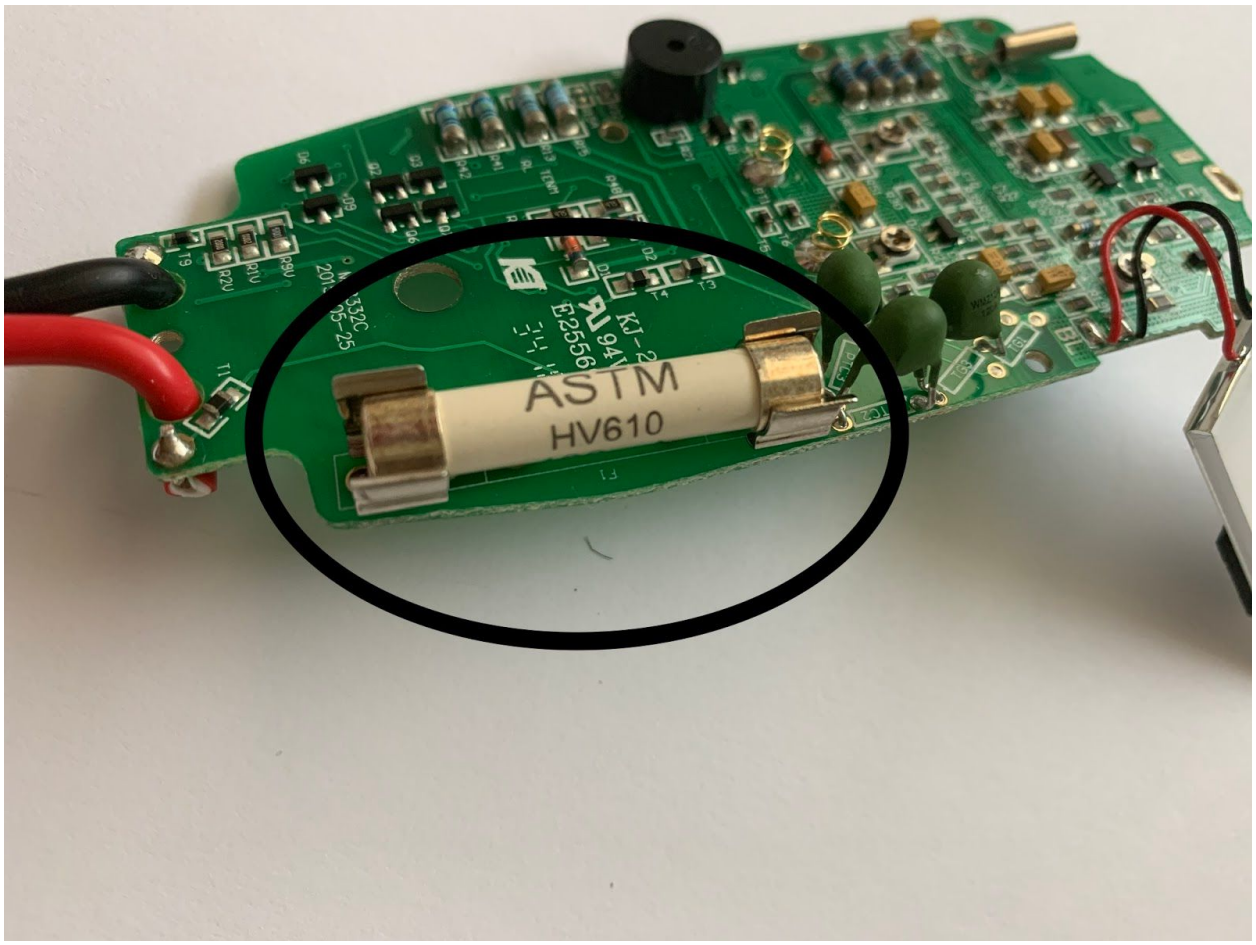


Circuit of the multimeter

Device Image (Circuit Diagram)

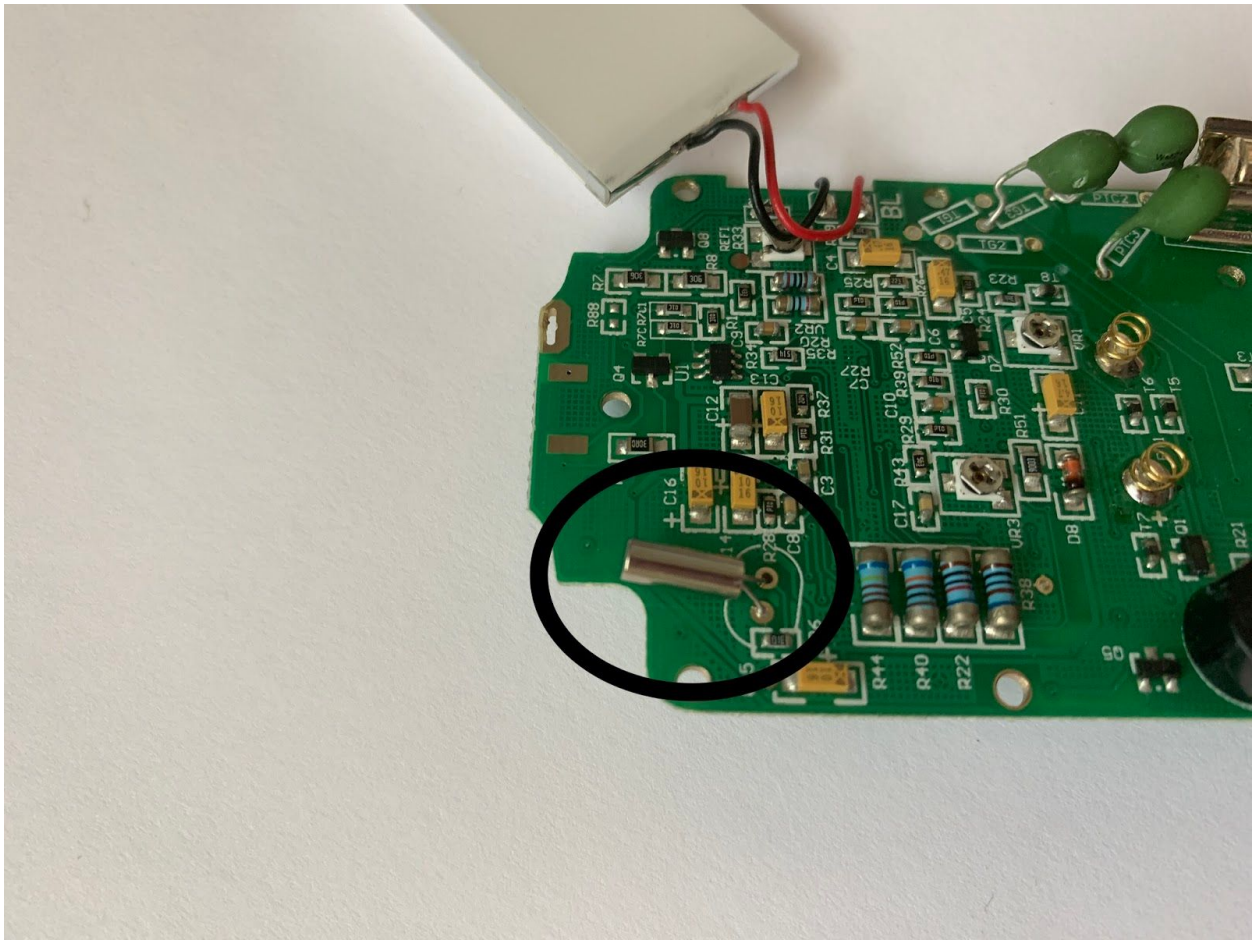


Device Image (Fuse)



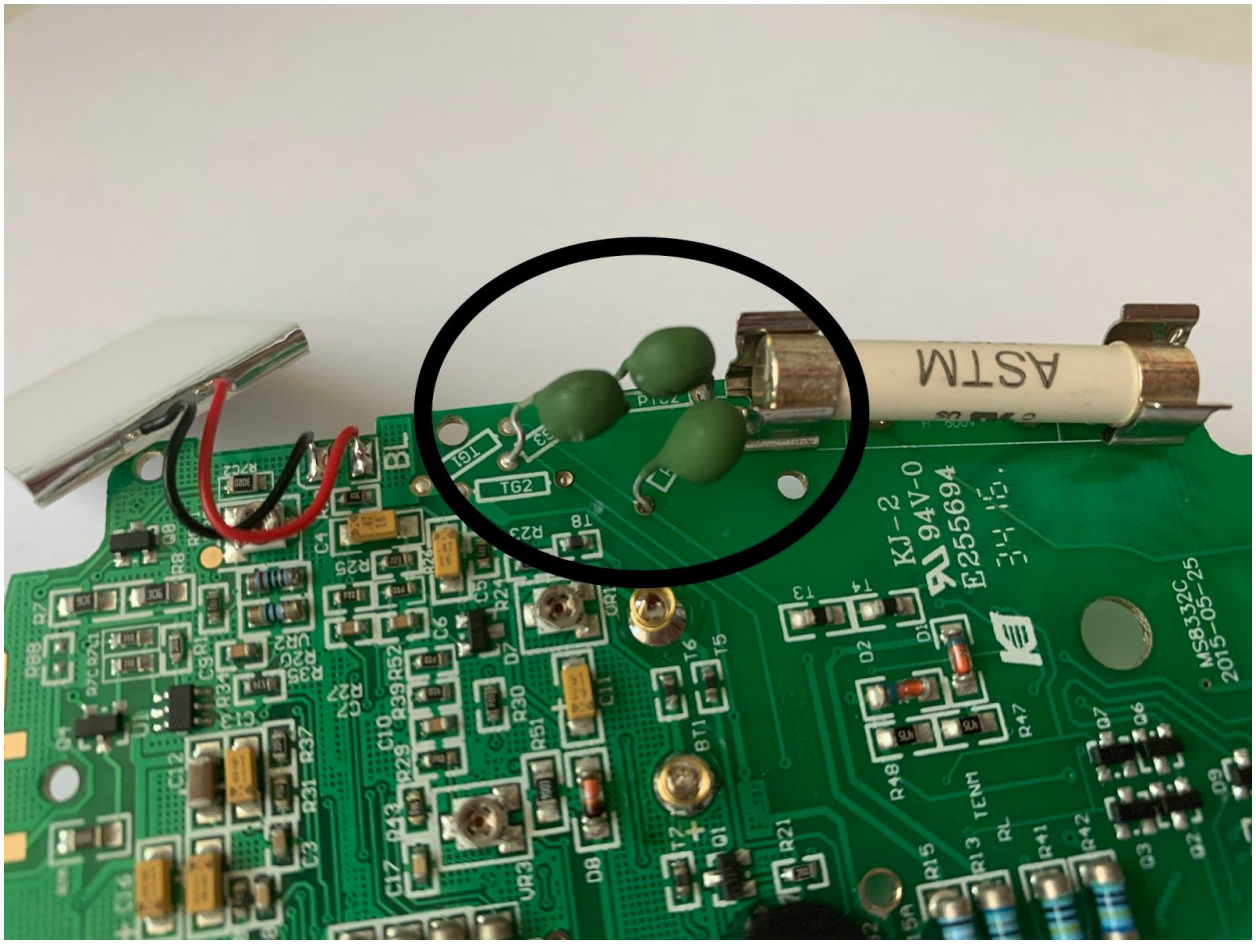
Fuse of the multimeter (HV610); 400mA; Protects the circuit from current overload

Device Image (Crystal Oscillator)



Crystal Oscillator; utilizes the mechanical resonance of a vibrating crystal to create an electronic signal with a constant frequency

Device Image (MOVs)



Metal Oxide Varistors; protect the circuit from high voltage spikes