NAVSEA Design Specification

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Version 0.9 from 5/24/2022

Revision History

Revision	Date	Author(s)	Description
0.1	10/28/2021	ZP, LM, JM	Created
0.2	10/31/2021	ZP, LM, JM	Added to requirements, enumerated sections
0.3	11/14/2021	ZP, LM, JM	Updated after Nov. 5th sponsor meeting
0.4	11/28/2021	ZP, LM, JM	Added Ethical Considerations,
0.5	1/24/2022	ZP, LM, JM	Added notes to system design and bill of materials
0.6	2/21/2022	ZP, LM, JM	Added to bill of materials, system architecture, and requirements
0.7	4/10/2022	ZP, LM, JM	Added to bill of materials
0.8	5/15/2022	ZP, LM, JM	Updated system architecture, system design
0.9	5/24/2022	ZP, LM, JM	updated system architecture picture, BOM, system design

Contents

1 Overview

This project entails the recreation of the MK.532, this device has the purpose of testing detonator resistances within the Navy's systems. The preexisting device is considered antiquated, recreating the device is being done to prevent future issues with its use.

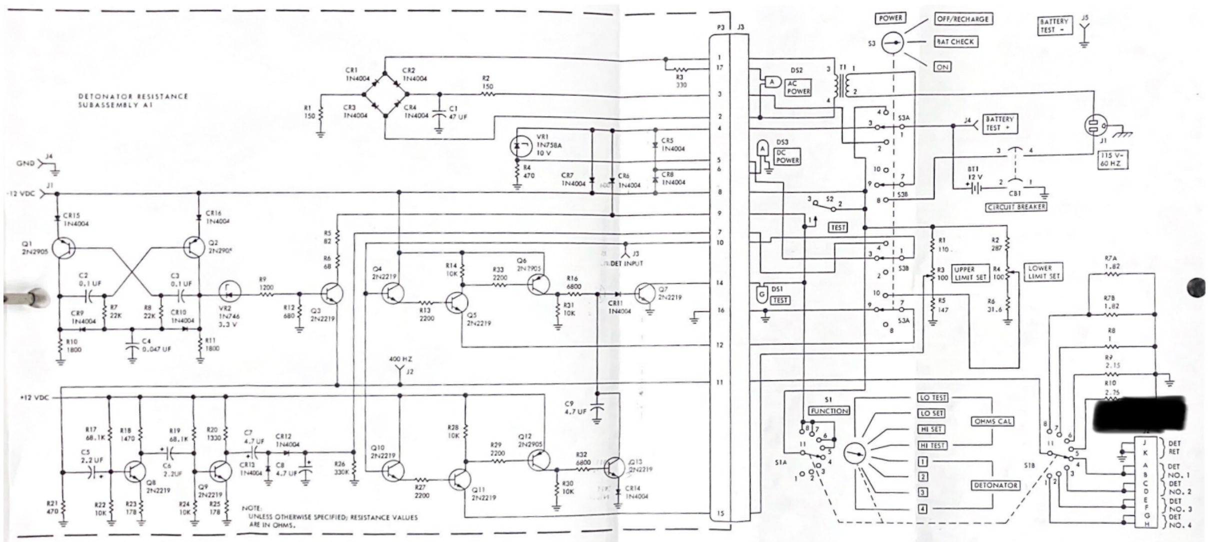

Figure 1: Original Schematic

2 Requirements

Must accurately detect resistances between 1.0 and 2.5 ohms. Values found outside of this range will be signaled via a light on the test set enclosure. The functionality of the redesigned test set must perfectly replicate the original including the wired connections between the test set and the detonator resistors. This will be done to ensure continuity for NAVSEA operators of the test set. Operator tests must also match the previously expected results.

3 System Architecture

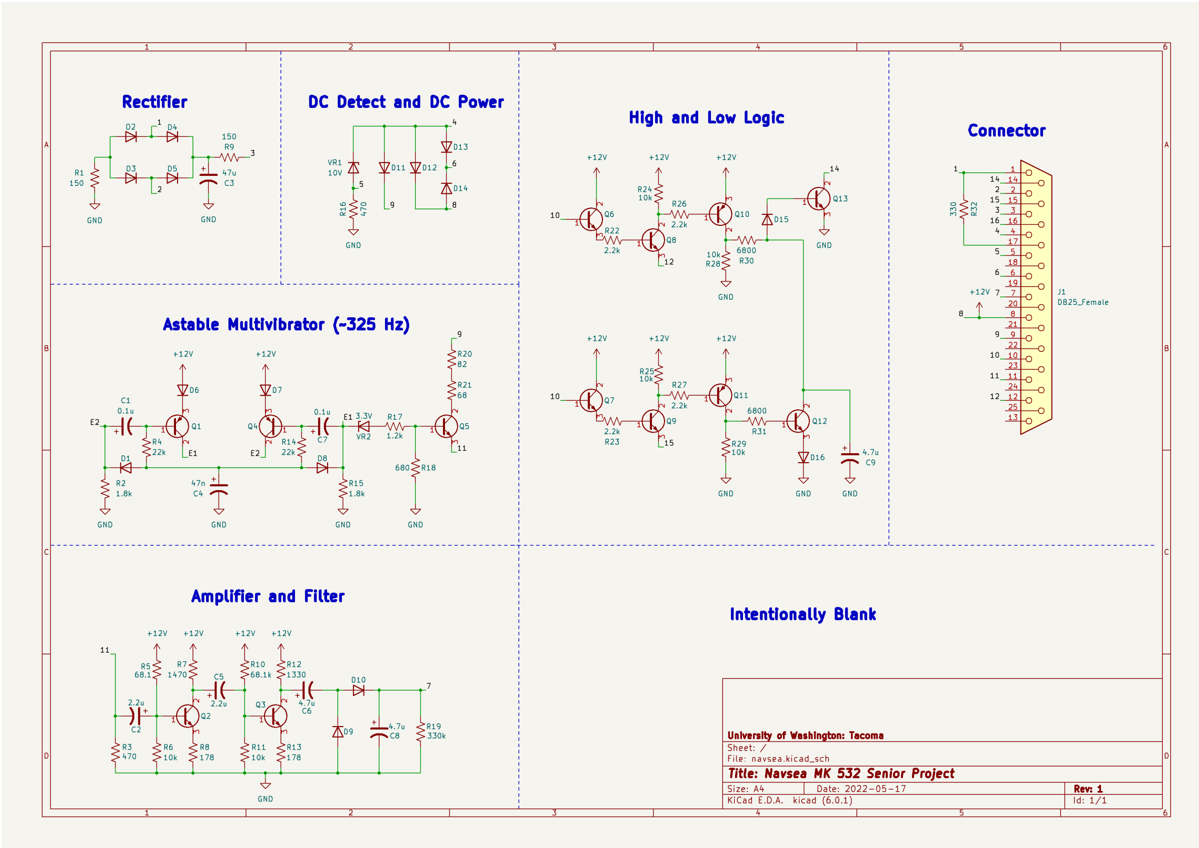

Figure 2: System Architecture

3.1 Original Architecture

The architecture of the final deliverable printed circuit board (PCB) will entirely be decided on the predecessor test kit. This includes all of the internal segments of this attached design. The PCB replicates the circuit logic from the original schematics. This can be seen in Figure 2 which shows the circuitry of the PCB mimicking the logic side of the original schematic (Figure 1). The circuit produces a 325 hz square wave signal out of the Astable Multivibrator, this signal goes across the DET resistor and the 470 ohm resistor (from the amplifier circuit) in parallel. The voltage drop of this signal is then sent through the Amplifier and Filter section which makes the difference in resistance more easily measured in DC voltage. This is then sent to the High and Low Logic which compares voltage values to verify if the resistor is within range or not.

The user interface side is meant to connect to the PCB through the female connector. If a smaller form factor is deemed necessary for the test set, it would be possible to expand upon the final deliverable to include this circuitry as well.

3.2 Proposed Alternative

The proposed alternative would replace the square wave generator, amplifier circuit, as well as the logic gate sections. The same logic can be done with a Wheatstone bridge and an accompanying op amp for the purpose of a comparator. The Wheatstone's variable resistor (R2) will replace the Upper and Lower limit sets of the original design. This new potentiometer will encompass the acceptable range of ohms (1.0 - 2.25), with an output LED attached across Vg. This design allows the operator to directly test the value of the DET resistor (Rx). When resistance values in the Wheatstone bridge are balanced Vg will have no voltage across it, thus extinguishing the output LED. Therefore if the operator is able to extinguish the light when rotating the potentiometer (R2) from one extreme to another, then the resistor is within range. This is a promising alternative as it would reduce costs as it contains less components than the existing logic. This route was ultimately not taken as it would change the required test procedures for test set operators. Additionally, this was tested and functional in digital simulations, but it was not determined if physical creations of this circuit will

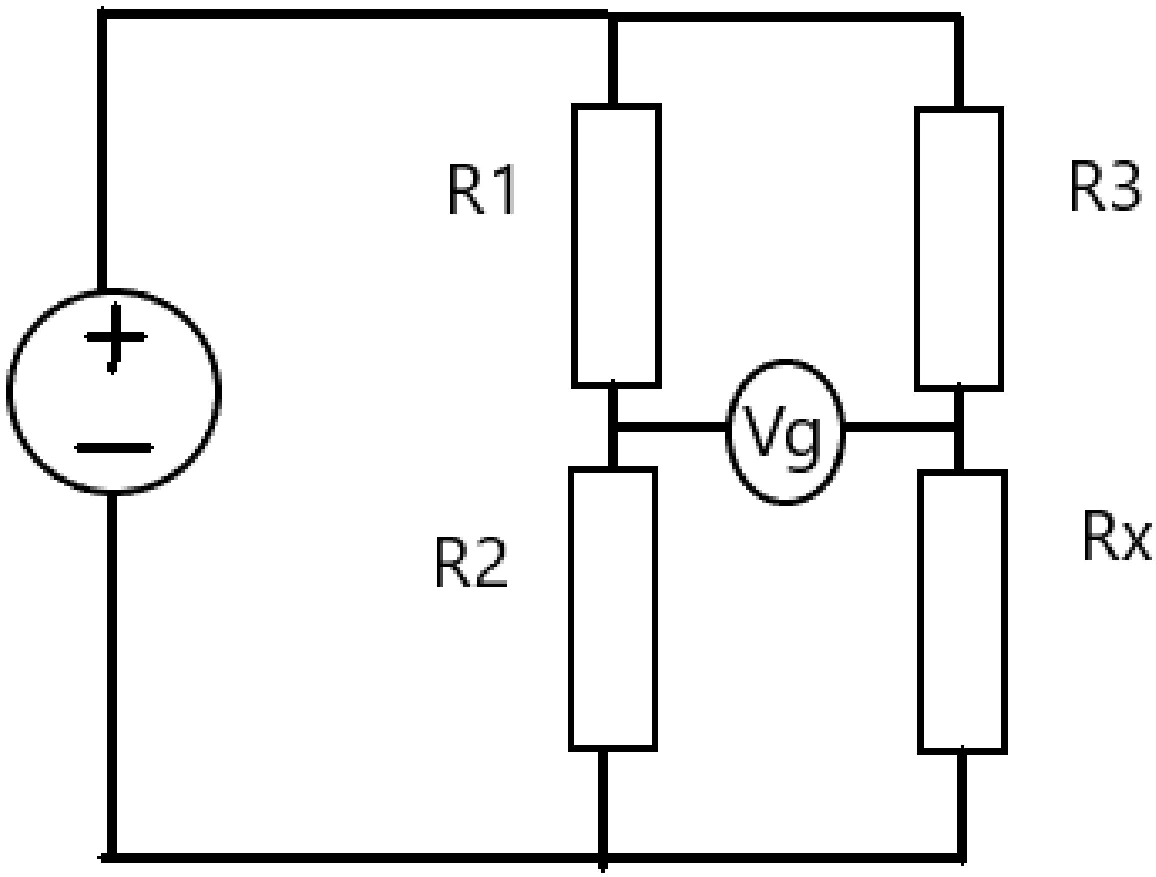

Figure 3: Wheatstone Bridge

4 System Design

Our design process will mostly pertain to the use of digital software such as KiCAD. This design will mimic the previously made design of the test set as we are expected to maintain it's uses with the new design.

4.1 User Interface

The "user interface" of this schematic involved all of the circuitry to the right of the large divider going down the middle of the NAVSEA provided schematic. These switches are what will interact with the redesigned PCB. The current housing of the MK.532 splits the user interface and logic into two sections. The user interface section is entirely comprised of wires and rotary switches. without the time to alter the housing, the PCB redesign has not included the user interface sections as it is less challenging to change and can be completed by those who follow up this project in implementing the PCB if a smaller form factor is deemed necessary.

4.2 AC to DC Converter

This section is a simple rectifier ciruit that converts the alternating current into direct current in order to charge the battery that operates the test equitment.

4.3 Square Wave Generator

This circuit produces a square wave with an amplitude of approximately eighty millivolts. This is the signal used to measure the resistance of the resistors. The test resistor is in parallel with another resistor at the beginning of the Amplifier circuit, this is done so that the small difference in resistance is more measure-able with the later amplified DC voltage.

4.4 Amplifier Circuit

This piece is what takes in the square wave signal and amplifies the value and converts it to a DC voltage. This is done so that the logic gates further along the circuit can compare this value to a dialed in voltage to compare the detonator resistors with test resistors. This makes it possible to identify the range of the detonator resistor.

4.5 Logic Gate Section

This circuit is what compares and voltage values to determine whether the DET resistance is in range or not. This is displayed via a incandescent bulb in the original design, or an LED from the new redesign named TEST.

5 Bill of Materials

The previous designs bill of materials was provided by Eric Theer, we have begun going over this list to validate their usability for our project. Due to change in sponsor expected deliverables this is no longer a primary concern as we are not expected to build a chip. Many of these items were not available for or use for various reasons. Because of this we will need to update the list accordingly. We will be using several parts not within military specifications. Thus final deliverables will require two sets of material lists. These will entail the components used for physical tests, and another to act as a list of potential components for NAVSEA to use in their implementation.

Type	Number	Value
Capacitor	C1	47 uF
Capacitor	C2-C3	100,000 pF
Capacitor	C4	47,000 pF
Capacitor	C5-C6	2,200,000 pF
Capacitor	C7-C9	4,700,000 pF
Diode	CR1-CR16	400V @ 1A
Diode	VR1	10V @ 350mA
Diode	VR2	3.3V @ 110mA
Resistor	R1-R2	150 Ω
Resistor	R3	330Ω
Resistor	R4	470Ω
Resistor	R5	82Ω
Resistor	R6	68Ω
Resistor	R7-R8	22kΩ
Resistor	R9	1.2kΩ
Resistor	R10-R11	1.8kΩ
Resistor	R12	680Ω
Resistor	R13	2.2kΩ
Resistor	R14	10kΩ
Resistor	R16	6.8kΩ
Resistor	R17/R19	68.1kΩ
Resistor	R18	1470 Ω

BOM

6 Ethical Considerations

This work will piggyback largely off the work of a previous senior design project student group led by Eric Theer, proper references to their original work will need to be maintained when completing this redesign.

In addition, the NAVSEA sponsors have declared that we will need to consider where our replacement parts are made. Specifically we were told components made in China were not to be permitted. All components used must meet Mil Spec requirements.

This test set is for the safety system of Naval systems. Thus our group is responsible for making sure that this test set is a reliable and long lasting method of ensuring the safety of military members.