Low-cost and power-efficient terahertz reconfigurable reflective surfaces for imaging and wireless communications

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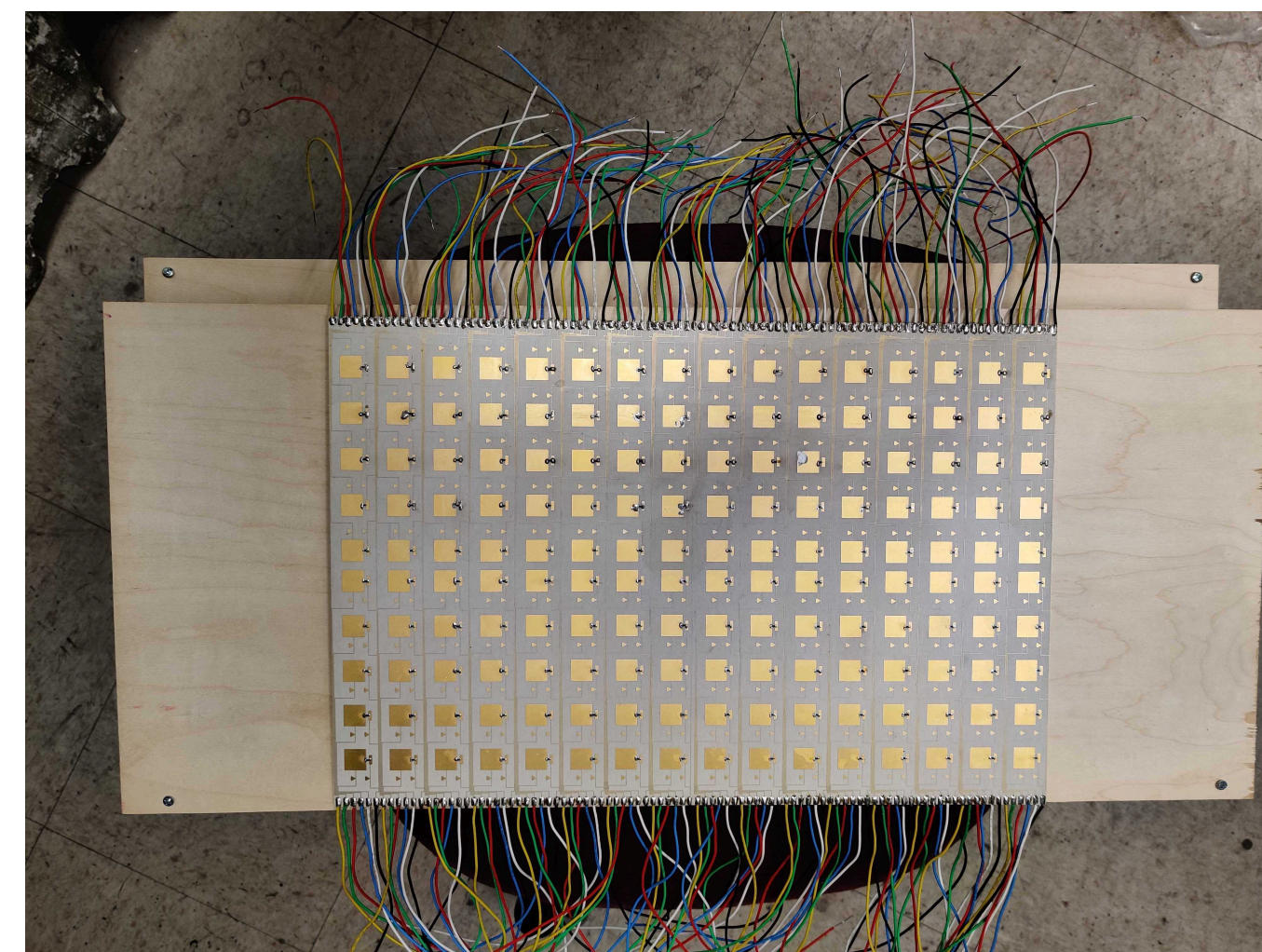## Abstract and Project Overview

Abstract

Reconfigurable reflectarrays aim to mitigate connection issues with wireless sensing, target tracing, artificial intelligence, and many other capabilities. Being able to establish and replicate an effective, low-cost DC biasing circuit for many types of reflectarrays would improve the process of implementing such devices in a wide range of orientations, configurations, and locations. This would allow for a stronger, more reliable, and direct signal for the end user.
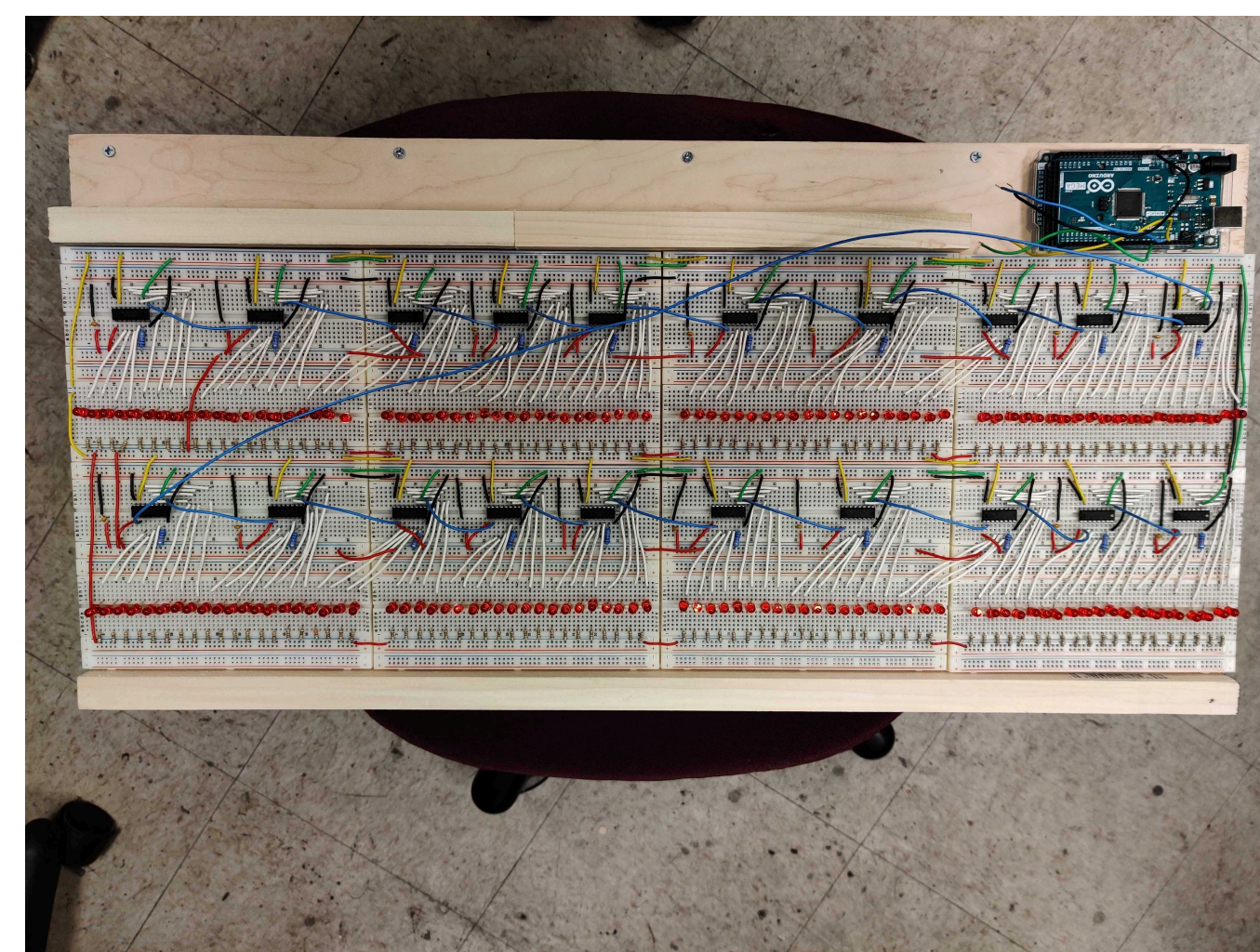
Backaround

- Initial interest started as early as 1980
- Combines the features of phase arrays and dish reflectors
- Has the unique ability to control individual beam aspects
- Specific frequency range of interest is millimeter waves
- Filling gaps in wireless communication and sensing

RSS surface with 160 antenna elements

Current Progress

The design team has currently fabricated a 160-element reflectarray with a DC-Biasing prototype board controlled by an Arduino Mega. With the design having undergone several simulations and tests regarding the operation at millimeter wavelengths, the next steps involve scaling up the array size with the intention of decreasing processing time and increasing the performance of the device. A small, robust, and easily replicable DC-biasing board will be needed to implement such a system.
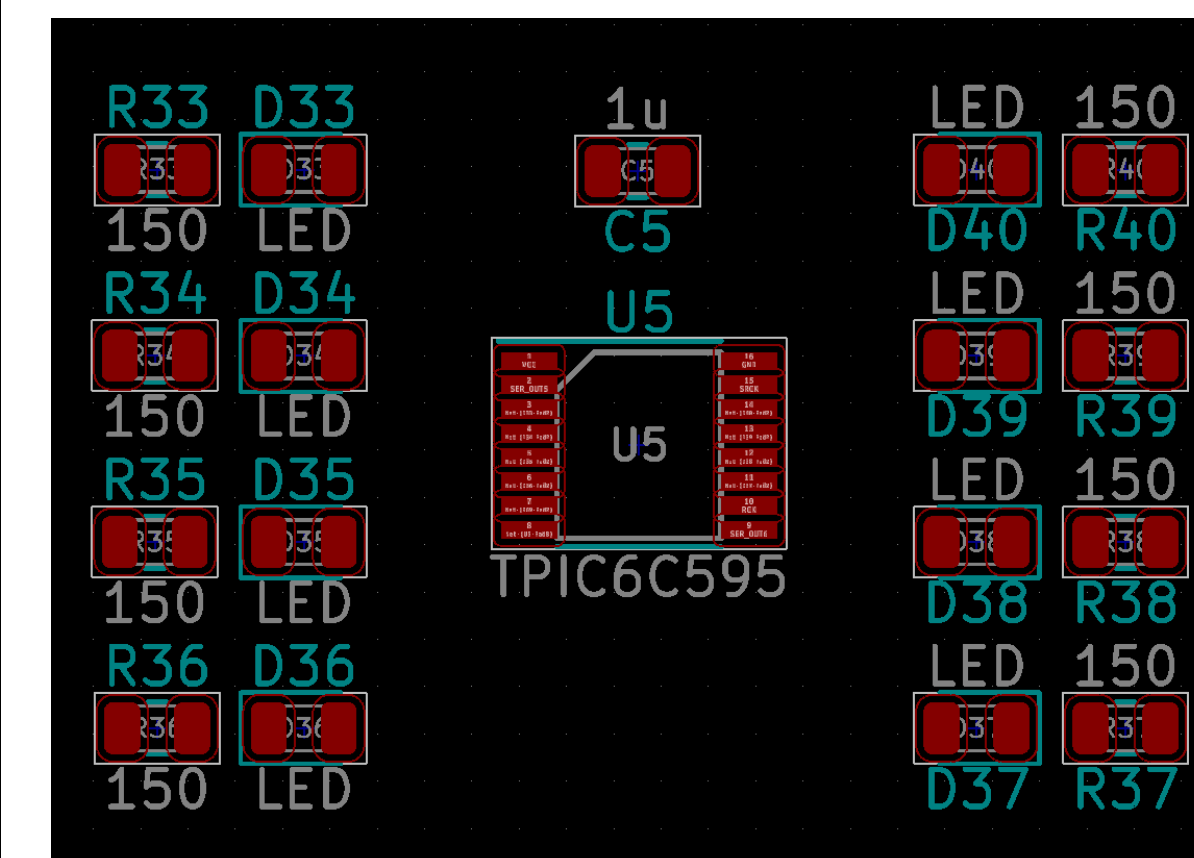

DC-biasing prototype circuit for reflectarray

Solution and Next Steps

*Snapshot of the component layout used for the bias board*

Solution

The current solution and design hurdles focus on how a large system can be condensed as much as possible on a small PCB board. The challenges involve optimal component placement for clean route tracing as well as finding a neat solution to the modular aspects of this build. The final design will share the same set-up as the prototype but will account for the intended ability to scale the usable shift register memory for a larger reflectarray. This will allow for the user to choose the specific number of biasing boards they would like for their build without reworking the original layout fitted for a single design.

Future Design and Concluding Remarks
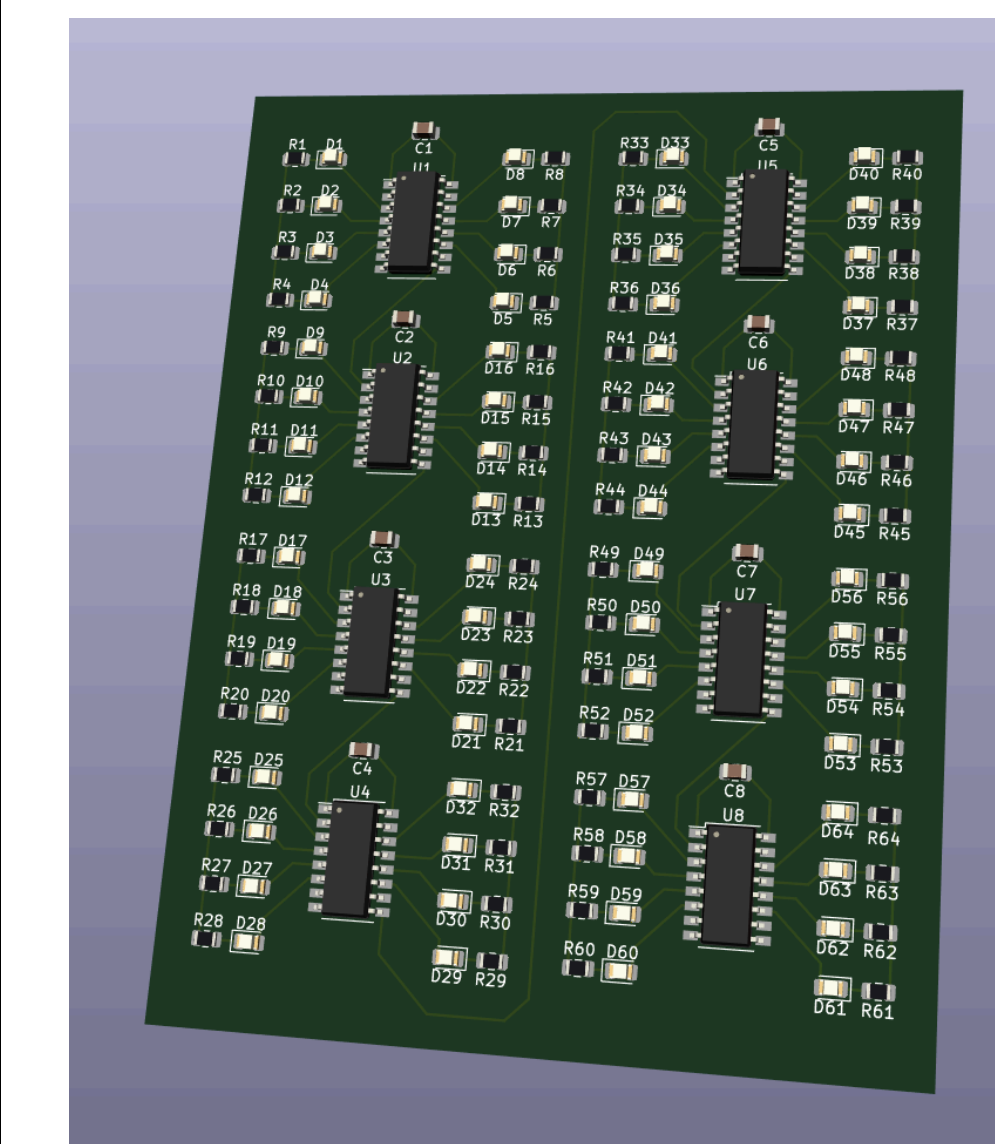
Rendering of condensed bias board with eight shift registers

The next step in finalizing a design for the DC-biasing board is to establish design methods so the implementation of the system is easy integratabtle with the current and newer revisions of the design. The scalability of reflectarrays should be apparent in the power and digital logic that aids the signal transmission. Creating a simple and easy to debug module runs tandem with the success of the reflectarray. The current design focuses on combining the modular aspects of breadboard design with the permanent solution of PCBs. Since a large PCB is non-ideal, finding a creative solution to fitting multiple biasing boards in series or parallel will ease overhead production costs and will allow for easy scalability.

Such an opportunity will allow for more ubiquitous uses of reflectarrays, highlighting their potential strengths in solving communication and imaging issues across a wide band of frequencies. Finding an interesting, low-cost solution to powering such units will help realize the potential of future communication.

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